

Content Standards Curriculum Framework

2005

Drafting

Electricity Trades

**Heating, Ventilating,
Air Conditioning, and
Refrigeration**

Trade and Industrial Education

Louisiana Department of Education

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Reaching For Results
Louisiana Department of
EDUCATION 



Foreword

Rapid changes are occurring in our world and economy. The increasing complexity of work that spans the entire work force of today's society demands that education for all students be made more relevant and useful to future careers. In response to these demands, Louisiana educators and citizens collaborated to develop an action plan to establish content standards that would raise the academic expectations of students. Their mission was "to develop rigorous and challenging standards that will enable all Louisiana students to become lifelong learners and productive citizens for the 21st century." These higher academic standards and their accompanying benchmarks, which further define the standards, require students to extend the learning they have acquired by applying knowledge and skills to real life, real work situations.

To prepare Louisiana Career and Technical Education students to meet the demands of society and the workplace in the 21st century, industry-based certification standards were developed to address content knowledge and the application of skills. These standards focus on what students should know, be able to do, and be able to demonstrate in the workplace. They promote and develop critical thinking processes, which students will use in the classroom and real work applications, address the diversity of educational needs of Louisiana students enrolled in vocational education courses, and address industry-based certification programs for employability.

Content standards have been developed for all Louisiana students, those who are gifted and talented, those with disabilities, as well as students who are linguistically and culturally diverse. Modifications for addressing their specific needs regarding curricula and instruction will be addressed through local education agencies (LEAs).

Louisiana has made significant strides towards improving the education of our children. Our goal is to build on our strengths as we continue to improve education in our state. By developing rigorous standards and challenging assessments that align with the standards and by holding schools accountable for results, we are ensuring a better future for all our children.

Title 28
EDUCATION

**Part CV. Bulletin-115—Trade and Industrial Education Content Standards Framework—
Drafting, Electricity, Heating, Ventilating, Air
Conditioning, and Refrigeration
Subpart 1. General Provisions**

Chapter 1. Purpose

§101. Introduction

A. The information contained in Subpart 1, General Provisions are applicable to Drafting; Electricity; and Heating, Ventilating, Air Conditioning, and Refrigeration (HVACR).

B. The Secondary Trade and Industrial Education Program in the State of Louisiana can be described as “a secondary program designed to prepare students for careers in business, industry, and the service occupations through a sequence of applied learning experiences.” Instructional units are provided in the use of layout, designing, producing, processing, assembling, testing, maintaining, and the servicing of industrial goods and products, as well as public services.

C. Intended Audience

1. The Louisiana Trade and Industrial Education curriculum framework is intended for a broad audience:

- a. trade and industrial education teachers;
- b. parents;
- c. school and district administrators;
- d. school board members;
- e. policy makers;
- f. Louisiana Department of Education staff;
- g. college/university faculty/administrators;
- h. business/industry leaders; and
- i. government agency staff.

2. The framework serves as a guide for curriculum and instruction and as a general reference to the concepts and skills taught within Louisiana Trade and Industrial Education courses. The intended users of the framework include:

- a. Trade and Industrial Education teachers—to use in planning:
 - i. curriculum;
 - ii. instruction; and
 - iii. assessment;
- b. parents—to use as a means of assessing the effectiveness of their children’s trade and industrial education;
- c. school and district administrators and school board members—to use as a vision for trade and industrial education and a basis for planning:
 - i. resource allocations;
 - ii. materials purchases;
 - iii. local curriculum development;
 - iv. teachers’ professional development; and
 - v. faculty recruitment;
- d. policy makers and state Education staff—to use as a basis for:

- i. developing laws, policies, professional development activities/materials, assessment strategies; and
- ii. funding priorities to support local program development;
- e. university faculty and administrators—to use as a basis for the content and design of pre-service and in-service teacher education programs and articulation agreements;
- f. technical college faculty and administrators—to use as a basis for articulation agreements and program development; and
- g. business/industry leaders and government agency staff—to use as a basis for developing effective partnerships for supporting trade and industrial education programs and professional development.

D. How Teachers Should Use this Part XCIX. This Part XCIX outlines the content appropriate to be taught in Louisiana Trade and Industrial Education programs. Local needs will determine what should be taught in local trade and industrial education programs. Although teachers will be able to use this framework to guide them in the restructuring of their curricula, this Part XCIX does not contain specific performance criteria that are essential in trade and industrial education. These specific assessment criteria must be developed on the local level.

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§103. Definitions

Academic Cross-Reference—a reference to related academic content standards.

Applied Academics—a method of teaching in which the instructor presents subject matter in a way that relates a particular academic discipline to personal workforce application.

Approved Program—a Business Education program that offers at least four of the recommended courses for a career major—two of which must be at the competency level.

Articulation—the process of linking two or more educational systems to produce a smooth flow of students from one institution to another without experiencing delays, duplication of courses, or loss of credit.

Assessment—a process through which evidence is gathered in a range of content areas to determine both a student's understanding and ability to apply that understanding.

Benchmark—a broad statement of expected skills and knowledge that is used as a reference to develop curriculum and assess student progress.

Career Clusters—broad categories of occupations that form the basis for initial career exploration and discovery.

Career Major—a specific course of study within a broader career cluster.

1. Example. Accounting within the Business career cluster.

Career Path—a plan of study that will enable a student upon graduation, to be employed or enter a postsecondary school with a continuation of skills or coursework already started at the high school level.

Career Plan—a student's written plan for career and educational goals while in secondary school and beyond.

Competency Course—a required course in a career major.

Content Standard—a description of what a student should know and be able to do through subject matter, knowledge, proficiencies, etc., gained as a result of his/her education.

Cooperative Learning—an instructional strategy used in many applied academic courses that involves learning in the context of sharing, responding, and communicating with other learners.

Curriculum Framework—an outline of broad goals and standards of a system of education.

Focus Statement—a statement describing the importance of a career major.

Foundation Skills—processes that are common to all areas and levels of education and are intended to suggest methods and objectives of instructional strategies.

High Schools That Work—a process model developed by the Southern Regional Education Board (SREB) that focuses on:

1. applied learning;
2. integration of academic and vocational content; and
3. school-to-work transitions.

Integrated—refers to combining elements across the strands within a particular contest area or framework.

Interdisciplinary—combining elements across content areas in the curriculum.

Lifelong Learning—the concept of continued education and training, formal and informal, throughout one's career.

Portfolios—personalized, sequential career planning journal designed to guide students through career development interests and aptitudes as they progress through school and beyond; including examples of student skill mastery.

Related Elective Course—an additional course offered to complement and enhance opportunities within a career major.

School-Based Learning—program of instruction based on career majors, designed to meet high academic and occupational skill standards, which involves counseling and career exploration, and periodic evaluation of academic strengths and weaknesses.

School-to-Work Transition—a system that enables students to identify and navigate paths to productive and progressively more rewarding roles in the workplace encompassing three components:

1. school-based learning;
2. connecting activities; and
3. work-based learning.

Skill Standard—the identification of the knowledge, skill, and level of ability needed to satisfactorily perform a given job.

Strands—concepts common to all content areas. *Strands* are interrelated and should be integrated rather than taught in isolation.

Tech Prep—a sequence of study beginning in high school and continuing through at least two years of postsecondary occupational education to prepare students for high skilled jobs that require more than a high school diploma.

Vocational Completer—a student who successfully completes four courses in a career major:

1. two must be competency courses; and
2. two must be selected from the competency courses and/or identified related electives.

Work-Based Learning—integration of theoretical instruction with a planned program of job training or experiences, paid work experience, workplace mentoring, instruction in general workplace competencies, and updating elements that will:

1. engage student interest;
2. develop positive work attitudes; and
3. prepare youth for high-skill, high-wage careers.

Workplace Mentor—an employee at the workplace who possesses the skills to be mastered by a student, and who:

1. instructs the student;
2. critiques the student's performance;
3. challenges the student to perform well; and
4. works in consultation with classroom teachers and the employer.

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§105. Mission Statement

A. To develop rigorous and challenging standards that will enable all Louisiana students to become lifelong learners and productive citizens for the twenty-first century.

B. This mission statement was developed by the Louisiana Statewide Content Standards Task Force in October 1995 and has served as the focus for the standards initiatives that have been developed by the Louisiana Department of Education. Along with this mission statement, the Task Force also identified five foundation skills that committee members felt should be embedded in all content areas to promote lifelong learning and to prepare Louisiana students to be successful in the next millennium.

C. The following five foundation skills serve as the backbone for the content standards initiative.

1. Communication
2. Problem Solving
3. Resource Access and Utilization
4. Linking and Generating Knowledge
5. Citizenship

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§107. Foundation Skills

A. Foundation Skill 1: Communication

1. Exchanging of information
2. Creating and sharing meaning
3. Applying the skills of:
 - a. reading;
 - b. writing;
 - c. speaking;
 - d. listening;
 - e. viewing; and

- f. visually representing in society and a variety of workplaces
- B. Foundation Skill 2: Problem Solving
 - 1. Recognizing and defining problems
 - 2. Identifying an obstacle or challenge
 - 3. Applying knowledge and thinking processes to reach a solution using multiple pathways
 - 4. Showing willingness to take risks in order to learn
 - 5. Persevering in the face of challenges and obstacles
 - 6. Utilizing the five senses as a resource for problem solving
 - 7. Analyzing past problems and applying basic knowledge to develop logical, creative, and practical strategies to predict, prevent, and solve problems
 - 8. Identifying and considering a variety of viewpoints in solving problems
 - 9. Developing, selecting, and applying strategies to solve existing and potential problems
 - 10. Selecting and applying appropriate technology and other resources to solve problems
 - 11. Verifying the appropriateness of the solution
 - 12. Analyzing and evaluating the results or consequences
- C. Foundation Skill 3: Resource Access and Utilization
 - 1. Identifying, locating, selecting, and using resource tools in analyzing, synthesizing, and communicating information
 - 2. Identifying, and employing appropriate tools, techniques, and technologies essential to the learning process, such as:
 - a. pen, pencil, and paper;
 - b. audio/video material;
 - c. word processors;
 - d. computer;
 - e. interactive devices;
 - f. telecommunications; and
 - g. other emerging technologies.
- D. Foundation Skill 4: Linking and Generating Knowledge
 - 1. Using cognitive processes to generate and link knowledge across the disciplines and in a variety of contexts
 - 2. Applying a strategy or content knowledge effectively in a setting or context other than that in which it was originally learned
 - 3. Monitoring, adjusting, and expanding strategies in other contexts
- E. Foundation Skill 5: Citizenship
 - 1. Understanding the ideals, rights, and responsibilities of active participation in a democratic republic
 - 2. Working respectfully and productively together for the benefit of the individual and the community
 - 3. Being accountable for one's choices and actions and understanding their impact on others
 - 4. Knowing one's civil, constitutional, and statutory rights
 - 5. Mentoring others to be productive citizens and lifelong learners

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Chapter 3. Louisiana Content Standards Foundation Skills

§301. Foundation Skills

A. The following foundation skills should apply to all students in all disciplines.

[Editor's Note: The foundation skills are listed numerically in parentheses after each benchmark]

1. Communication—a process by which information is exchanged and a concept of *meaning* is created and shared between individuals through a common system of symbols, signs, or behavior. Students should be able to communicate clearly, fluently, strategically, technologically, critically, and creatively in society and in a variety of workplaces. This process can best be accomplished through the use of the following skills:

- a. reading;
- b. writing;
- c. speaking;
- d. listening;
- e. viewing; and
- f. visually representing.

2. Problem Solving—the identification of an obstacle or challenge and the subsequent application of knowledge and thinking processes, which include reasoning, decision making, and inquiry in order to reach a solution using multiple pathways, even when no routine path is apparent.

3. Resource Access and Utilization—the process of identifying, locating, selecting, and using resource tools to help in analyzing, synthesizing, and communicating information. The identification and employment of appropriate tools, techniques, and technologies are essential to all learning processes. These resource tools include:

- a. pen, pencil, and paper;
- b. audio/video materials;
- c. word processors;
- d. computers;
- e. interactive devices;
- f. telecommunication; and
- g. other emerging technologies.

4. Linking and Generating Knowledge—the effective use of cognitive processes to generate and link knowledge across the disciplines and in a variety of contexts. In order to engage in the principles of continual improvement, students must be able to transfer and elaborate on these processes. *Transfer* refers to the ability to apply a strategy or content knowledge effectively in a setting or context other than that in which it was originally learned. *Elaboration* refers to monitoring, adjusting, and expanding strategies into other contexts.

5. Citizenship—the application of the understanding of the ideals, rights, and responsibilities of active participation in a democratic republic that includes working respectfully and productively together for:

- a. the benefit of the individual and the community;
- b. being accountable for one's civil, constitutional, and statutory rights; and
- c. mentoring others to become productive citizens and lifelong learners.

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Chapter 5. Standards and Benchmarks

§501. Introduction

A. Standards and benchmarks provide a framework for local curriculum development. A school district's physical facilities, available equipment, resources, and community and business support are only a few of the factors that make the system unique and determine the curriculum offered.

B. In using this framework to develop curriculum, a *standard* is the major outcome of a course and *benchmarks* are the goals for obtaining that outcome. Local systems will select the career majors to be offered, the courses offered in these majors, and create the objectives and activities that teachers will use to direct their instruction to reach the benchmarks for the selected courses. This procedure will allow local systems to structure curriculum to meet the needs of their students, schools, and communities while remaining consistent with the overall framework for the entire state.

C. Local systems will use the career majors as a guide to select the courses that will be offered for each major. Not all career majors or all courses listed with the major in this framework must be offered locally. Employment opportunities and postsecondary education availability in the local area should be considered as curriculum is developed.

D. To be identified as a vocational completer, a student must successfully complete four courses in a career major:

1. two of which *must be* competency courses; and
2. two of which must be selected from the competency courses and/or related elective courses identified in the career major.

E. Following each career major are the content standards that relate to the major. They identify what students should know and be able to do. In the column beside each standard are benchmarks that identify specific skills and knowledge and serve as points of reference to gauge student progress toward achievement of standards. Benchmarks set the direction of instruction.

F. Cross-references to academic content standards reinforce the integration of academic and technology skills. English Language Arts, Mathematics, Social Studies, and Science academic standards are cross-referenced in the third column beside each Technology Education standard. The referenced academic standards are listed in full in Chapter 7. Codes used in the table to identify the academic standards are given in below.

1. ELA=English Language Arts
 - a. Standard number is given, then benchmark number
2. Mathematics
 - a. Strand letter is given, then benchmark number
N - Number and Number Relations Strand
A - Algebra Strand
M - Measurement Strand
G - Geometry Strand
D - Data, Discrete Math, and Probability Strand
P - Patterns, Relations, and Functions Strand
3. Social Studies
 - a. Strand letter is given, then benchmark letter and number
G - Geography Strand
C - Civics Strand

E – Economics Strand

H – History Strand

4. Science

a. Strand letter is given, then benchmark letter and number

SI – Science as Inquiry Strand

PS – Physical Science Strand

LS – Life Science Strand

SE – Science and the Environment Strand

ESS – Earth Science Strand

5. Arts

a. Strand letter is given, then benchmark letter and number

CE – Creative Expression

AP – Aesthetic Perception

HP – Historical and Cultural Perception

CA – Critical Analysis

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Chapter 7. Academic Cross-References

§701. Introduction

A. This Chapter 7 lists the content standards and benchmarks that have been referenced in Drafting; Electricity; and Heating, Ventilating, Air Conditioning, and Refrigeration (HVACR). All referenced content area standards and benchmarks are for students in grades 9 – 12—indicated as “H” for high school, e.g.:

Code: ELA-1-H1:

ELA=English Language Arts;

1=Standard

H1=High School, Benchmark Number.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10) and R.S. 17:10.

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§703. English Language Arts (ELA)

A. Standard One. Students read, comprehend, and respond to a range of materials, using a variety of strategies for different purposes.

ELA-1-H1	Using knowledge of word meaning and extending basic and technical vocabulary employing a variety of strategies (e.g., context clues, affixes, etymology, dictionary, thesaurus).
ELA-1-H2	Analyzing the effects of complex literary devices (e.g., figurative language, flashback, foreshadowing, dialogue, irony) and complex elements (e.g., setting, plot, character, theme, mood, style) on a selection.
ELA-1-H3	Reading, comprehending, and responding to extended, complex written, spoken, and visual texts.
ELA-1-H4	Interpreting complex texts with supportive explanations to generate connections to real-life situations and other texts (e.g., business, technical, scientific).
ELA-1-H5	Using the various purposes for reading (e.g., enjoying, learning, researching, problem-solving) to complete complex projects.

B. Standard Two. Students write competently for a variety of purposes and audiences.

ELA-2-H1	Writing a composition of complexity that clearly implies a central idea with supporting details in a logical, sequential order.
ELA-2-H2	Using language, concepts, and ideas that show an awareness of the intended audience and/or purpose (e.g., classroom, real-life, workplace) in developing complex compositions.
ELA-2-H3	Applying the steps of the writing process, emphasizing revising and editing in final drafts.
ELA-2-H4	Using narration, description, exposition, and persuasion to develop various modes of writing (e.g., notes, stories, poems, letters, essays, editorials, critical analyses, logs).
ELA-2-H5	Recognizing and applying literary devices (e.g., figurative language, symbolism, dialogue) and various stylistic elements (e.g., diction, sentence structure, voice tone).
ELA-2-H6	Writing as a response to texts and life experiences (e.g., technical writing, resumés).

C. Standard Three. Students communicate using standard English grammar, usage, sentence structure, punctuation, capitalization, spelling, and handwriting.

ELA-3-H1	Writing legibly
ELA-3-H2	Using the grammatical and mechanical conventions of standard English.

ELA-3-H3	Spelling accurately using strategies and resources (e.g., glossary, dictionary, thesaurus, spell check) when necessary.
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D. Standard Four. Students demonstrate competence in speaking and listening as tools for learning and communicating.

ELA-4-H1	Speaking intelligibly, using standard English pronunciation and diction.
ELA-4-H2	Giving and following directions/procedures.
ELA-4-H3	Using the features of speaking (e.g., audience analysis, message construction, delivery, interpretation of feedback) when giving prepared and impromptu presentations.
ELA-4-H4	Speaking and listening for a variety of audiences (e.g., classroom, real-life, workplace) and purposes (e.g., awareness, concentration, enjoyment, information, problem solving).
ELA-4-H5	Listening and responding to a wide variety of media (e.g., music, TV, film, speech, CD-ROM).
ELA-4-H6	Participating in a variety of roles in group discussions (e.g., active listener, contributor, discussion leader, facilitator, recorder, mediator).

E. Standard Five. Students locate, select, and synthesize information from a variety of texts, media, references, and technological sources to acquire and communicate knowledge.

ELA-5-H1	Recognizing and using organizational features of printed text, other media, and electronic information (e.g., parts of texts, citations, endnotes, bibliographic references, microprint, laser discs, hypertext, CD-ROM, keyword searches, bulletin boards, e-mail).
ELA-5-H2	Locating and evaluating information sources (e.g., print materials, databases, CD-ROM references, Internet information, electronic reference works, community and government data, television and radio resources, audio and visual materials).
ELA-5-H3	Accessing information and conducting research using graphic organizers, outlining, note taking, summarizing, interviewing, and surveying to produce documented texts and graphics.
ELA-5-H4	Using available technology to produce, revise, and publish a variety of works.
ELA-5-H5	Citing references using various formats (e.g., parenthetical citations, endnotes, bibliography).
ELA-5-H6	Interpreting graphic organizers (e.g., charts/graphs, tables/schedules, diagrams/maps, organizational charts/flowcharts).

F. Standard Six. Students read, analyze, and respond to literature as a record of life experiences.

ELA-6-H1	Identifying, analyzing, and responding to United States and world literature that represents the experiences and traditions of diverse ethnic groups.
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G. Standard Seven. Students apply reasoning and problem-solving skills to their reading, writing, speaking, listening, viewing, and visually representing.

ELA-7-H1	Using comprehension strategies (e.g., predicting, drawing conclusions, comparing and contrasting, making inferences, determining main ideas, summarizing, recognizing literary devices, paraphrasing) in contexts.
ELA-7-H2	Problem-solving by analyzing, prioritizing, categorizing, and evaluating; incorporating life experiences; and using available information.
ELA-7-H3	Analyzing the effects of an author's life, culture, and philosophical assumptions and an author's purpose and point of view.

ELA-7-H4	Distinguishing fact from opinion, skimming and scanning for facts, determining cause and effect, generating inquiry, and making connections with real-life situations across texts.
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§705. Mathematics

A. Number and Number Relations Strand (N). In problem-solving investigations, students demonstrate an understanding of the real number system and communicate the relationships within that system using a variety of techniques and tools.

N-1-H	Demonstrating an understanding of the real number system.
N-2-H	Demonstrating that a number can be expressed in many forms, and selecting an appropriate form for a given situation (e.g., fractions, decimals, percents, and scientific notation).
N-3-H	Using number sense to estimate and determine if solutions are reasonable.
N-4-H	Determining whether an exact or approximate answer is necessary.
N-5-H	Selecting and using appropriate computational methods and tools for given situations (e.g., estimation, or exact computation using mental arithmetic, calculator, symbolic manipulator, or paper and pencil).
N-6-H	Applying ratios and proportional thinking in a variety of situations (e.g., finding a missing term of a proportion).
N-7-H	Justifying reasonableness of solutions and verifying results.

B. Algebra Strand (A). In problem-solving investigations, students demonstrate an understanding of concepts and processes that allow them to analyze, represent, and describe relationships among variable quantities and to apply algebraic methods to real-world situations.

A-1-H	Demonstrating the ability to translate real-world situations (e.g., distance versus time relationships, population growth functions for diseases, growth of minimum wage, auto insurance tables) into algebraic expressions, equations, and inequalities and vice versa.
A-2-H	Recognizing the relationship between operations involving real numbers and operations involving algebraic expressions.
A-3-H	Using tables and graphs as tools to interpret algebraic expressions, equations, and inequalities.
A-4-H	Solving algebraic equations and inequalities using a variety of techniques with the appropriate tools (e.g., hand-held manipulatives, graphing calculator, symbolic manipulator, or pencil and paper).

C. Measurement Strand (M). In problem-solving investigations, students demonstrate an understanding of the concepts, processes, and real-life applications of measurements.

M-1-H	Selecting and using appropriate units, techniques, and tools to measure quantities in order to achieve specified degrees of precision, accuracy, and error (or tolerance) of measurements.
M-2-H	Demonstrating an intuitive sense of measurement (e.g., estimating and determining reasonableness of results as related to area, volume, mass, rate, and distance).
M-3-H	Estimating, computing, and applying physical measurement using suitable units (e.g., calculate perimeter and area of plane figures, surface area and volume of solids presented in

	real-world situations).
M-4-H	Demonstrating the concept of measurement as it applies to real-world experiences.

D. Geometry Strand (G). In problem-solving investigations, students demonstrate an understanding of geometric concepts and applications involving one-, two-, and three-dimensional geometry, and justify their findings.

G-1-H	Identifying, describing, comparing, constructing, and classifying geometric figures in two and three dimensions using technology where appropriate to explore and make conjectures about geometric concepts and figures.
G-2-H	Representing and solving problems using geometric models and the properties of those models (e.g., Pythagorean Theorem or formulas involving radius, diameter, and circumference).
G-3-H	Solving problems using coordinate methods, as well as synthetic and transformational methods (e.g., transform on a coordinate plane a design found in real-life situations).
G-4-H	Using inductive reasoning to predict, discover, and apply geometric properties and relationships (e.g., patty paper constructions, sum of the angles in a polygon).
G-5-H	Classifying figures in terms of congruence and similarity and applying these relationships.
G-6-H	Demonstrating deductive reasoning and mathematical justification (e.g., oral explanation, informal proof, and paragraph proof).

E. Data, Discrete Math, and Probability Strand (D). In problem-solving investigations, students discover trends, formulate conjectures regarding cause-and-effect relationships, and demonstrate critical thinking skills in order to make informed decisions.

D-2-H	Recognizing data that relate two variables as linear, exponential, or otherwise in
D-3-H	Using simulations to estimate probabilities (e.g., lists and tree diagrams).
D-4-H	Demonstrating an understanding of the calculation of finite probabilities using permutations, combinations, sample spaces, and geometric figures.
D-7-H	Making inferences from data that are organized in charts, tables, and graphs (e.g., pictograph; bar, line, or circle graph; stem-and-leaf plot or scatter plot).
D-8-H	Using logical thinking procedures, such as flow charts, Venn diagrams, and truth tables.
D-9-H	Using discrete math to model real-life situations (e.g., fair games or elections, map coloring).

F. Patterns, Relations, and Functions (P). In problem-solving investigations, students demonstrate understanding of patterns, relations, and functions that represent and explain real-world situations.

P-1-H	Modeling the concepts of variables, functions, and relations as they occur in the real world and using the appropriate notation and terminology.
P-2-H	Translating between tabular, symbolic, or graphic representations of functions.
P-3-H	Recognizing behavior of families of elementary functions, such as polynomial, trigonometric, and exponential functions, and, where appropriate, using graphing technologies to represent them.
P-4-H	Analyzing the effects of changes in parameters (e.g., coefficients and constants) on the graphs of functions, using technology whenever possible.
P-5-H	Analyzing real-world relationships that can be modeled by elementary functions.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10) and R.S. 17:10.

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§707. Social Studies

A. Geography Strand: Physical and Cultural Systems (G). Students develop a spatial understanding of Earth's surface and the processes that shape it, the connections between people and places, and the relationship between man and his environment.

1. Benchmark A: The World in Spatial Terms

G-1A-H1	Using geographic representations, tools, and technologies to explain, analyze, and solve geographic problems.
G-1A-H2	Organizing geographic information and answering complex questions by formulating mental maps of places and regions.

2. Benchmark B: Places and Regions

G-1B-H1	Determining how location and social, cultural, and economic processes affect the features and significance of places.
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3. Benchmark C: Physical and Human Systems

G-1C-H1 Analyzing the ways in which Earth's dynamic and interactive physical processes affect different regions of the world.

G-1C-H2 Determining the economic, political, and social factors that contribute to human migration and settlement patterns and evaluating their impact on physical and human systems.

4. Benchmark D: Environment and Society

G-1D-H1	Describing and evaluating the ways in which technology has expanded the human capability to modify the physical environment.
G-1D-H2	Examining the challenges placed on human systems by the physical environment and formulating strategies to deal with these challenges.
G-1D-H3	Analyzing the relationship between natural resources and the exploration, colonization, settlement, and uses of land in different regions of the world.
G-1D-H4	Evaluating policies and programs related to the use of natural resources.
G-1D-H5	Developing plans to solve local and regional geographic problems related to contemporary issues.

B. Civics Strand: Citizenship and Government (C). Students develop an understanding of the structure and purposes of government, the foundations of the American democratic system, and the role of the United States in the world, while learning about the rights and responsibilities of citizenship.

1. Benchmark A: Structure and purposes of Government

C-1A-H1	Analyzing the necessity and purposes of politics and government and identifying examples of programs that fit within those purposes.
C-1A-H5	Evaluating the role and importance of law in the American political system and applying criteria to evaluate laws.

C. Economics Strand: Interdependence and Decision Making (E). Students develop an understanding of fundamental economic concepts as they apply them to the interdependence

and decision making of individuals, households, businesses, and governments in the United States and the world.

1. Benchmark A: Fundamental Economic Concepts

E-1A-H1	Analyzing the impact of the scarcity of productive resources and examining the choices and opportunity cost that result.
E-1A-H2	Analyzing the roles that production, distribution, and consumption play in economic decisions.
E-1A-H3	Applying the skills and knowledge necessary in making decisions about career options.
E-1A-H4	Comparing and evaluating economic systems.
E-1A-H5	Explaining the basic features of market structures and exchanges.
E-1A-H6	Analyzing the roles of economic institutions, such as corporations and labor unions, that compose economic systems.

2. Benchmark B: Individuals, Households, Businesses and Governments.

E-1B-H1	Identifying factors that cause changes in supply and demand.
E-1B-H1	Analyzing how changes in supply and demand, price, incentives, and profit influence production and distribution in a competitive market system.
E-1B-H1	Analyzing the impact of governmental taxation, spending, and regulation on different groups in a market economy.
E-1B-H1	Analyzing the causes and consequences of worldwide economic interdependence.
E-1B-H1	Evaluating the effects of domestic policies on international trade.
E-1B-H1	Analyzing Louisiana's role in the national and world economies.

3. Benchmark C: The Economy as a Whole

E-1C-H2	Explaining how interest rates, investments, and inflation/deflation impact the economy.
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D. History Strand: Time Continuity, and Change (H). Students develop a sense of historical time and historical perspective as they study the history of their community, state, nation, and world.

1. Benchmark A: Historical Thinking Skills

H-1A-H1	Applying key concepts, such as chronology and conflict, to explain and analyze patterns of historical change and continuity.
H-1A-H2	Explaining and analyzing events, ideas, and issues within a historical context.
H-1A-H3	Interpreting and evaluating the historical evidence presented in primary and secondary sources.
H-1A-H4	Utilizing knowledge of facts and concepts drawn from history and methods of historical inquiry to analyze historical and contemporary issues.
H-1A-H5	Conducting research in efforts to analyze historical questions and issues.
H-1A-H6	Analyzing cause-effect relationships.

2. Benchmark B: United States History

a. Era 6: The Development of the Industrial United States (1870-1900).

H-1B-H6	Analyzing the development of industrialization and examining its impact on American society.
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H-1B-H16	Explaining the major changes that have resulted as the United States has moved from an industrial to an information society.
H-1B-H17	Analyzing developments and issues in contemporary American society.

3. Benchmark C: World History
 - a. Era 9: The Twentieth Century since 1945 (1945 to the present)

H-1C-H15	Explaining the worldwide significance of major political, economic, social, cultural, and technological developments and trends.
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HISTORICAL NOTE: Promulgated by the Department of Education, Board of Elementary and Secondary Education, Trade and Industrial Education, LR 32::

§709. Science

A. Science as Inquiry Strand (SI). Students will *do* science by engaging in partial and full inquiries that are within their developmental capabilities.

1. Benchmark A: The Abilities Necessary to do Scientific Inquiry

SI-H-A1	Identifying questions and concepts that guide scientific investigations.
SI-H-A2	Designing and conducting scientific investigations.
SI-H-A3	Using technology and mathematics to improve investigations and communications.
SI-H-A4	Formulating and revising scientific explanations and models using logic and evidence.
SI-H-A5	Recognizing and analyzing alternative explanations and models.
SI-H-A6	Communicating and defending a scientific argument.
SI-H-A7	Utilizing science safety procedures during scientific investigations.

2. Benchmark B: Understanding Scientific Inquiry

SI-H-B2	Communicating that scientists conduct investigations for a variety of reasons, such as: exploration of new areas; discovery of new aspects of the natural world; confirmation of prior investigations; evaluation of current theories; and comparison of models and theories.
SI-H-B3	Communicating that scientists rely on technology to enhance the gathering and manipulation of data.
SI-H-B4	Analyzing a proposed explanation of scientific evidence according to the following criteria: follow a logical structure; follow rules of evidence; allow for questions and modifications based on historical and current scientific knowledge.
SI-H-B5	Communicating that the results of scientific inquiry, new knowledge, and methods emerge from different types of investigations and public communication among scientists.

B. Physical Science Strand (PS). Students will develop an understanding of the characteristics and interrelationships of matter and energy in the physical world.

1. Benchmark B: Atomic Structure

PS-H-B1	Describing the structure of the atom and identifying and characterizing the particles that compose it (including the structure and properties of isotopes).
PS-H-B2	Describing the nature and importance of radioactive isotopes and nuclear reactions (fission, fusion, radioactive decay).
PS-H-B3	Understanding that an atom's electron configuration, particularly that of the outer-most electrons, determines the chemical properties of that atom.

2. Benchmark C: The Structure and Properties of Matter

PS-H-C1	Distinguishing among elements, compounds, and/or mixtures.
PS-H-C2	Discovering the patterns of physical and chemical properties found on the periodic table of the elements.
PS-H-C6	Recognizing that carbon atoms can bond to one another in chains, rings, and branching networks to form a variety of structures.
PS-H-C7	Using the kinetic theory to describe the behavior of atoms and molecules during the phase changes and to describe the behavior of matter in its different phases.

3. Benchmark D: Chemical Reactions

PS-H-D1	Observing and describing changes in matter and citing evidence of chemical change.
PS-H-D6	Comparing and contrasting the energy changes that accompany changes in matter.
PS-H-D7	Identifying important chemical reactions that occur in living systems, the home, industry and the environment.

4. Benchmark E: Forces and Motion

PS-H-E1	Recognizing the characteristics and relative strengths of the forces of nature (gravitational, electrical, magnetic, nuclear).
PS-H-E2	Understanding the relationship of displacement, time, rate of motion, and rate of change of motion; representing rate and changes of motion mathematically and graphically.
PS-H-E3	Understanding effects of forces on changes in motion as explained by Newtonian mechanics.
PS-H-E4	Illustrating how frame of reference affects our ability to judge motion.

5. Benchmark F: Energy

PS-H-F1	Describing and representing relationships among energy, work, power, and efficiency.
PS-H-F2	Applying the universal law of conservation of matter, energy, and momentum, and recognizing their implications.

6. Benchmark G: Interactions of Energy and Matter

PS-H-G1	Giving examples of the transport of energy through wave action.
PS-H-G2	Analyzing the relationship and interaction of magnetic and electrical fields and the forces they produce.
PS-H-G3	Characterizing and differentiating electromagnetic and mechanical waves and their effects on objects as well as humans.
PS-H-G4	Explaining the possible hazards of exposure to various forms and amounts of energy.

C. Earth Science Strand (ESS). Students will develop an understanding of the properties of Earth's materials, the structure of the Earth's system, the Earth's history, and the Earth's place in the universe.

[**WARNING:** Benchmarks for grades 9 – 12 need to be addressed if Earth Science is not offered at the high school level.]

1. Benchmark A: Energy in the Earth System

ESS-H-A1	Investigating the methods of energy transfer and identifying the sun as the major source of energy for most of the Earth's systems.
ESS-H-A2	Modeling the seasonal changes in the relative position and appearance of the sun and inferring the consequences with respect to the Earth's temperature.
ESS-H-A3	Explaining fission and fusion in relation to the Earth's internal and external heat sources.
ESS-H-A5	Demonstrating how the sun's radiant energy causes convection currents within the atmosphere and the oceans.

2. Benchmark B: Geochemical Cycles

ESS-H-B1 Illustrating how stable chemical atoms or elements are recycled through the solid earth, oceans, atmosphere, and organisms.

ESS-H-B2 Demonstrating Earth's internal and external energy sources as forces in moving chemical atoms or elements.

D. Science and the Environment Strand (SE). In learning environmental science, students will develop an appreciation of the natural environment, learn the importance of environmental quality, and acquire a sense of stewardship. As consumers and citizens, they will be able to recognize how our personal, professional, and political actions affect the natural world.

1. Benchmark A: Ecological Systems and Interactions

SE-H-A1	Demonstrating an understanding of the functions of Earth's major ecological systems.
SE-H-A2	Investigating the flow of energy in ecological systems.
SE-H-A9	Demonstrating an understanding of influencing factors of biodiversity.
SE-H-A10	Explaining that all species represent a vital link in a complex web of interaction.
SE-H-A11	Understanding how pollutants can affect living systems.

2. Benchmark B: Resources and Resource Management

SE-H-B1	Explaining the relationship between renewable and nonrenewable resources.
SE-H-B2	Comparing and contrasting conserving and preserving resources.
SE-H-B3	Recognizing that population size and geographic and economic factors result in the inequitable distribution of the Earth's resources.
SE-H-B4	Comparing and contrasting long and short-term consequences of resource management
SE-H-B5	Analyzing resource management.
SE-H-B6	Recognizing that sustainable development is a process of change in which resource use, investment direction, technological development, and institutional change meet society's present as well as future needs.

3. Benchmark C: Environmental Awareness and Protection

SE-H-C1	Evaluating the dynamic interaction of land, water, and air and its relationship to living things
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	in maintaining a healthy environment.
SE-H-C2	Evaluating the relationships between quality of life and environmental quality.
SE-H-C3	Investigating and communicating how environmental policy is formed by the interaction of social, economic, technological, and political considerations.
SE-H-C4	Demonstrating that environmental decisions include analyses that incorporate ecological, health, social, and economic factors.
SE-H-C5	Analyzing how public support affects the creation and enforcement of environmental laws and regulations.

4. Benchmark D: Personal Choices and Responsible Actions

SE-H-D1	Demonstrating the effects of personal choices and actions on the natural environment.
SE-H-D2	Analyzing how individuals are capable of reducing and reversing their impact on the environment through thinking, planning, education, collaboration, and action.
SE-H-D3	Demonstrating that the most important factor in prevention and control of pollution is education.
SE-H-D4	Demonstrating a knowledge that environmental issues should be a local and global concern.
SE-H-D5	Recognizing that the development of accountability toward the environment is essential for sustainability.
SE-H-D6	Developing an awareness of personal responsibility as stewards of the local and global environment.

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HISTORICAL NOTE: Promulgated by the Department of Education, Board of Elementary and Secondary Education, Trade and Industrial Education, LR 32:

§711. Arts

A. Creative Expression (CE). Students develop creative expression through the application of knowledge, ideas, skills, and organizational abilities.

CE-1VA-H1	Producing works of art that successfully convey a central thought based on ideas, feelings, and memories.
CE-1VA-H2	Applying a variety of media techniques, technologies, and processes for visual expression and communication.
CE-1VA-H3	Recognizing and utilizing individual expression through the use of the elements of design while exploring compositional problems.
CE-1VA-H4	Producing a visual representation of ideas derived through the study of various cultures, disciplines, and art careers.
CE-1VA-H5	Producing imaginative works of art generated from individual and group ideas.

B. Aesthetic Perception (AP). Students develop aesthetic perception through the knowledge of art forms and respect for commonalities and differences.

AP-2VA-H1	Using an expanded art/design vocabulary when responding to the aesthetic qualities of a work of art.
AP-2VA-H2	Analyzing unique characteristics of art as it reflects the quality of everyday life in various cultures.
AP-2VA-H3	Using descriptors, analogies, and other metaphors to describe interrelationships observed in works of art, nature, and the total environment.
AP-2VA-H4	Assimilating the multiple possibilities and options available for artistic expression.

C. Historical and Cultural Perception (HP). Students develop historical and cultural perception by recognizing and understanding that the arts throughout history are a record of human experience with a past, present, and future.

HP-3VA-H1	Categorizing specific styles and periods of art as they relate to various cultural, political, and economic conditions.
HP-3VA-H2	Analyzing how works of art cross geographical, political, and historical boundaries.
HP-3VA-H4	Analyzing materials, technologies, media, and processes of the visual arts throughout history.
HP-3VA-H5	Identifying the roles of artists who have achieved recognition and ways their works have influenced the community.

D. Critical Analysis (CA). Students will make informed judgments about the arts by developing critical analysis skills through study of and exposure to the arts.

CA-4VA-H1	Translating knowledge of the design elements and principles to communicate individual ideas.
CA-4VA-H2	Working individually/collectively to compare and contrast symbols and images in the visual arts within historical periods and in other core curricula.
CA-4VA-H3	Comparing and contrasting the processes, subjects, and media of the visual arts.
CA-4VA-H4	Analyzing how specific works are created and how they relate to cultures and to historical periods.

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Subpart 3. Drafting

Chapter 9. Drafting Program Rationale

§901. Introduction

A. Refer to Subpart 1 of this Part XCIX for General Provisions applicable to this Drafting Program.

B. This course introduces the drafting trainee to the drafting trade, including the apprenticeship process and the opportunities within the trade.

C. Learning Objectives. Upon completion of this course, the trainee will be able to:

1. describe the history of the drafting occupation;
2. identify the stages of progress within the drafting occupation;
3. identify the responsibilities of a person working in the drafting profession;
4. state the personal characteristics of a professional;
5. explain the importance of safety in the drafting occupation.

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Chapter 11. Drafting Training Certification

Subchapter A. General Certification

§1101. Introduction

A. The purpose of certification is to give recognition (certification) to schools whose curriculum in design/drafting meets the standards established and approved by the American Design Drafting Association (ADDA).

B.. The program also provides a means of encouraging schools to develop and upgrade design/drafting curriculum in order to better prepare students to meet job requirements.

C. Request for Certification. A request for certification is implemented by a school official requesting the ADDA Certification Committee evaluate the curriculum. The evaluation is accomplished by examination of the school's curriculum; by interviews with faculty and graduates; by the use of references; by examination of data from catalogs, texts, courses, and other school publications; and by inspection of school facilities, if required.

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§1103. Eligibility for Certification

A. The reliability of the following criteria depends upon establishing and adhering to an equitable procedure of evaluation.

B. General Requirements. A school that offers an organized curriculum of two or more years directed toward the preparation for employment of the designer and drafter may make application for certification. Certification may be requested when the curriculum has been in operation a minimum of two years.

C. Types of Schools Eligible. The types of schools eligible for certification are those offering courses leading to a diploma, certificate, or degree in design/drafting. These are:

1. colleges and universities, including branches or divisions;
2. technical institutes, including private, public, or endowed;
3. junior or community colleges;
4. trade schools, including private, public, or endowed;
5. post-secondary schools or vocational-technical schools;
6. high schools and vocational high schools;
7. vocational and training schools that supplement academic programs.

D. Ethical and Financial Status. The school must have a reputation for being fair and factual in all its dealings with students and the public, and maintain a high standard of ethics in all operations. The school shall give evidence of having adequate financial support for normal operation.

E. Physical Plant

1. Floor Space. Space should be adequate (classroom: approximately 22 square feet per student; drawing room: approximately 75 square feet per student) to accommodate all students, and should avoid the use of labs and drawing rooms by more than one class at the same time.

2. Equipment. Equipment in drawing labs should be equivalent to the minimum acceptable equipment used in industry, and should be supplied in sufficient quantity to permit usage by all students without "doubling up." All equipment should be in good condition,

and provisions should be made for adequate storage. Laboratory and shop equipment should be adequate for student use and for demonstration.

3. Lighting. All classrooms and laboratories should be lit with a minimum of 100-foot candles.

4. Housekeeping. Work areas should be neat and clean. Premises should be cleaned daily. The students should be instructed and supervised in the proper care and usage of equipment and premises.

F. Types of Curriculum Certified. The curriculum may be certified for different levels and offered in any one of the various design/drafting fields, supported by specified related or background studies. The drafting courses shall be technological in nature, with emphasis placed on the graphical rather than analytical solutions of problems (See §7111 for ADDA Levels of Curriculum).

G. Length of Curriculum. The curriculum shall be at least two academic years of full-time residence work or equivalent in part-time or extension work. See “ADDA Levels of Curriculum” for credit/clock hour requirements (§7111).

H. Faculty Qualification

1. A desire to teach is an essential characteristic, but both the educational level of the faculty and their industrial or related experiences are additionally important. They should be experienced and competent, and should have proven ability in the subjects they teach.

2. Participation of faculty members in professional societies related to their field is a desirable practice. The ratio of instructors to students, as well as faculty teaching loads, should be such that quality instruction is enhanced.

I. Industry Advisory Committee

1. ADDA requires that the schools have or establish an advisory committee composed of three or more representatives of local industries. The committee shall assist the school in the promulgation of their design or drafting curriculum, and act as a continuing liaison between the educational institution and industry.

2. It shall be the responsibility of the school to report to ADDA the names of all members of this committee, with their addresses, business connections, and titles.

3. The committee should meet periodically at the school for observation, discussion, and advice. A written report from the advisory committee should be attached to the school’s Annual Certification Renewal Form that contains the general condition of design/drafting curriculum, school facilities, faculty performance, and recommendations. Favorable yearly reports will have paramount importance in certification renewals.

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Subchapter B. Curriculum Evaluation

§1105. Basis for Evaluation

A. It is intended that the basis for evaluating curriculum be sufficiently broad and liberal in scope to permit evaluators to work within reasonable limits in determining value of curriculum and eligibility for certification. Since there is considerable diversity in design/drafting courses and variations of the many types of schools that offer them, it is necessary to set certain minimum requirements.

B. Statement of Purpose. For each curriculum the school shall prepare a definitive statement mentioning the types and levels of employment open to graduates of that curriculum. One basis for certification is the extent to which the curriculum enables the student to handle the type and level of employment.

C. Attainment of Employment

1. One indication of the quality and content of any curriculum may be found by examining the following factors:

a. the percentage of graduates placed in jobs for which they are trained;

b. the job level attained by graduates after a five-year period;

c. the length of employment;

d. passing the ADDA Drafter Certification Exam.

2. Each application for certification shall include an employment report indicating the type and level of employment obtained by graduates and the names and addresses of firms employing the graduates.

3. The examining committee is instructed to recognize the difficulty in obtaining complete records of graduates five years after graduation; therefore, the school should make records as complete as possible. A record of continuing education is accepted in lieu of employment record.

D. Curriculum Analysis

1. Drafter–Community College or Vo-Tech

a. In view of the diversity of methods for evaluating credit, the following method shall be utilized as a basis for equitable evaluation and comparison.

i. Assuming that two hours of preparation or outside problem work by the student are required for each hour of lecture or recitation, the total workload may be gauged by the formula $3T + L - C$, where T is theory or recitation contact hours, L is lab contact hours (includes work on board and/or CAD in drafting room), and C is curriculum workload.

b. The application of the above formula cannot alone serve as a basis for conclusion, but it does produce a figure below which special consideration should be given with respect to quantity of content and academic level of courses included in the curriculum.

2. Apprentice Drafter–Post-Secondary School or Vo-Tech

a. The evaluation for this program will be based on the training institute's ability to ensure the student is provided with instruction that covers subjects listed in the "ADDA Test Objectives." A recommended guide for instruction is to use the customary one-hour of lecture for each two hours of lab time.

3. Vocational/Training Schools that Supplement Academic Programs. The evaluation for this program will be based on the training institute's ability to provide the technical instruction recommended at the drafter and apprentice drafter levels. Specifically, at the drafter level for programs working with community colleges or vo-tech schools, a minimum of 900 clock hours of instruction in Technical Drawing should be provided. At the apprentice drafter level for programs working with post-secondary or vo-tech schools, a minimum of 800 clock hours of instruction in Technical Drawing should be provided. At the apprentice drafter level for programs working with high schools or vocational high schools, a minimum of 600 hours (50 percent theory, 50 percent lab) of instruction in the Disciplines of Drafting and Design and Drafting Production Techniques should be provided. These recommendations are outlined in the ADDA Levels of Curriculum section.

E. Academic Level. The academic level of approved curriculum shall include 2, 3, and 4-year curriculum.

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§1107. ADDA Levels of Curriculum

A. It is recognized that instruction and training in the field of drafting and/or design can be given in various degrees and levels of accomplishment. The following outline indicates the specifications applying to the levels of curriculum, ranging from secondary schooling to a university degree. It is not intended herein that the terms limit or establish industry classifications or identifications having similar designations.

1. Engineering Designer—Baccalaureate Degree University

a. The four-year degree must meet all the requirements defined below, in addition to those shown in the technical college or institute outline for design drafter.

CREDITS	SUBJECTS
6 – 12	ADVANCED DESIGN COURSES (Advanced Machine Design, Dynamics, Fluid Mechanics, Kinematics, Special Departmental Design Project Courses)
3 – 12	MANAGEMENT DEVELOPMENT COURSES (Principles of Supervision, Industrial Organization, Management, Office Administration)
3 – 12	DESIGN GRAPHICS COURSES (Computer Graphics, Pipe Drafting, Structural Drafting, Highway Drafting, Civil Drafting)

2. Design Drafter—Technical College or Institute

a. Four or more semesters, 60-70 semester credits are recommended (60 credit minimum)

CREDITS	SUBJECTS
10– 15	TECHNICAL DRAWING (Basic, Machine Architectural, Electrical, Mapping, Piping, Structural, Technical Illustration, Technical/Sketching, Tool Detailing, Jig and Fixture, and Advanced Descriptive Geometry)
2 – 4	DESCRIPTIVE GEOMETRY
4 – 8	PHYSICAL SCIENCES (Physics*, Chemistry)
6 – 12	MATH – COLLEGE LEVEL (Algebra*, Trigonometry*, Analytic Geometry)
6 – 10	STATICS, STRENGTH OF MATERIALS, PROPERTIES OF MATERIALS
4 – 8	MANUFACTURING PROCESSES (Machine Shop, Welding, Foundry)
3 – 9	COMMUNICATIONS (English Composition*, Report Writing, Speech)
5 – 15	RELATED SPECIALTY COURSES

	(Electricity*, Survey, Business Machines, Elementary Machines Design, Computer Aided Drafting, Hydraulics, Economics, Accounting, Numerical Control)
0 - 3	INSTITUTIONAL ELECTIVES (subject matter to satisfy special institutional requirements, e.g., History, Government, P.E.)

*Specifically recommended

3. Drafter–Community College or Vo-Tech (excludes apprentice drafter)
 - a. 50-60 semester credits are recommended (50 credit minimum – 1,340 clock hours minimum)

CLOCKED HOURS	CREDITS	SUBJECTS
900-200	15-20	TECHNICAL DRAWING (Basic, Machine, Architectural, Electrical, Mapping, Piping, Structural, Technical Illustration, Technical/Sketching, Tool Detailing, Jig and Fixture, and Advanced Descriptive Geometry, Geometric Dimensioning and Tolerancing and CAD)
40 - 80	2-4	DESCRIPTIVE GEOMETRY
80 – 160	4 – 8	BASIC SCIENCES (Applied Physics, Mechanics, Chemistry)
40 – 120	4 – 8	MATH – COLLEGE LEVEL (Algebra*, Trigonometry*)
40 – 120	2 – 6	MANUFACTURING PROCESSES (Machine Shop*, Metal Shop, Foundry, Welding)
40 – 120	2 – 6	PROPERTIES OF MATERIALS
60 – 120	3 – 6	COMMUNICATIONS (English Composition, Business English, Report Writing)
100 - 200	5 – 10	RELATED SPECIALTY COURSES (Custom Menus, Plane and Solid Geometry, Computer Programming)

*Specifically recommended

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10) and R.S. 17:10.

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§1109. Vocational and Training Schools that Supplement Academic Programs

A. When a vocational or training school is used in conjunction with an academic program to provide instruction and training in the field of drafting and/or design, it is recognized that the Vocational/Training School will provide the required 900-1,200 clock hours of instruction and the student will receive the remaining coursework at the academic institution.

1. Apprentice Drafter–Post-Secondary School or Vo-Tech. It is recommended that a minimum of 400 clock hours in the core curriculum be required. The student’s total curriculum should provide the opportunity to obtain the knowledge and skills required to successfully pass the ADDA Drafter Certification test.

CLOCKED HOURS	CREDITS	SUBJECTS
		TECHNICAL DRAWING (Care, Machine, Architectural, Electrical, Electromechanical,

800-1000	15 – 20	Mapping, Piping, Structural, Technical Illustration, Technical/Sketching, Tool Detailing, Jig and Fixture, and Advanced Descriptive Geometry, Geometric Dimensioning and Tolerancing and CAD)
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2. Apprentice Drafter – High School or Vocational High School Level. To qualify for certification at the high school/vocational high school level, the drafting program must include the following subjects:

<p><i>English:</i> four years <i>Math:</i> three years minimum (i.e., Algebra, Geometry, Trigonometry) <i>Science:</i> three years (i.e., Biology, Chemistry, Physics) Disciplines of Drafting and Design: <i>Architecture:</i> Residential, Commercial, Structural Steel, Design/Drafting Techniques <i>Civil:</i> Basic civil design/drafting principles (i.e., site plans) <i>Mechanical:</i> Basic mechanical design/drafting principles and techniques <i>Electro/Mechanical:</i> Basic electro/mechanical design/drafting principles and techniques <i>Drafting Production Techniques</i></p>

a. The drafting program course of study must be at least two years in length (usually grades 11 and 12) with class contact of 150 hours per semester (300 hours per school year). Program evaluation will be based on the formula 50 percent theory/50 percent lab. When a vocational or training school is used to provide training and instruction in drafting or design in conjunction with the academic institution, it is recognized that the student will receive instruction in the Disciplines of Drafting and Design and Drafting Production Techniques at the vocational/training school.

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§1111. Subjects

A. Drawing Courses

1. For Engineering Designer or Design Drafter, the curriculum must be equally complete in the theory and technique of drafting, but must also extend into the field of engineering and design with which they are associated. They must encompass the ability to make use of graphic principles in the solution of problems relating to design/drafting.

2. The curriculum for Drafter and Apprentice Drafter should contain not only basic, but also advanced drawing courses in one or more specialized fields. The courses should provide the student with a complete foundation in the theory and technique of drafting. They should offer training to develop:

- a. manual skill in the use of instruments;
- b. the ability to do neat, legible, free-hand lettering and sketching in the area of specialization; and
- c. computer-aided drafting (CAD) systems.

3. It is understood that drawing courses involve not only drawing board and CAD practice in a formal class, but also lecture, discussion and individual guidance, as may be

suitable, from an instructor present in the class. It is recommended that, when applicable, “Design” courses include a finished drawing product, as well as computation and access to and use of catalogs, standard parts lists, commercial accessories, etc., as necessary.

B. Applied Technical Courses (includes basic sciences)

1. Courses that equip the drafting student with technical information directly related to his or her ultimate duties as a drafter, and without the use of which he or she could be no more than a copyist, are classified as applied technical specialties. In the area of machine drafting, courses falling under this heading include such subjects as:

- a. metallurgy;
- b. mechanics;
- c. materials and testing;
- d. metal shop;
- e. machine operations;
- f. production planning;
- g. chemistry;
- h. physics; and
- i. computer science.

C. Mathematics. The Drafter curriculum should include algebra, geometry, and trigonometry at the post-high school level. In the two higher classifications, analytic geometry and calculus should be required or integrated in design courses. It is expected the treatment will be oriented toward the needs of the profession.

D. General Subjects (English, Communications, Leadership, Humanities, and others). Subjects which contribute to the overall improvement of a student and to his/her development as a citizen, but which are not directly related to his/her activities as a designer or drafter, are included under this heading. All levels include an allowance for studies under this general heading.

Note: Subjects 2 through 4 are to be omitted from the curricular requirements for Apprentice Drafter – Post-Secondary School or Vo-Tech. Students are encouraged to continue their education for those subjects at a community college or university.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10) and R.S. 17:10.

HISTORICAL NOTE: Promulgated by the Department of Education, Board of Elementary and Secondary Education, Trade and Industrial Education, LR 31:

Chapter 13. National Occupational Skills Standards

§1301. Competencies, Foundation Skills, and Academic Cross-References

A. Standard 1: Fundamental Drafting Skills

Benchmarks	Louisiana Foundation Skills	Academic Cross-Reference Standard-Benchmark
A. DRAWING MEDIA AND RELATED DRAFTING MATERIALS		English Language Arts (ELA) ELA 1—H1, H3, H4, H5 ELA 3—H1, H2, H3 ELA 4—H2, H5 ELA 5—H1, H2, H3, H4, H6 ELA 7—H1
(1) Identify the characteristics and types of vellum, mylar, paper, etc.	1, 3	
(2) Select drawing media from among the following choices: mylar, vellum, paper, etc.	1, 2, 3, 4	
(3) Identify the characteristics and types of vellum, mylar, plotting pens, plotting pencils, ink, and toner cartridges.	1, 2, 3, 4	
(4) Select related drafting materials from among the following choices: plotting pens, plotting pencils, ink, and toner cartridges. Consider the following criteria: costs, equipment, use, compatibility, and accuracy.	1, 2, 3, 4	Mathematics N – 1H, 2H, 3H, 4H, 5H
B. BASIC MEASUREMENT SYSTEMS		M – 1H, 2H, 3H, 4H
(1) List the elements of the English/Imperial system and the metric system.	1, 3, 4	G – 2H, 3H, 6H
(2) Identify basic measurement systems using: fractions, decimals, metric, English, degrees, and radians.	1, 3, 4	D—None P—None
(3) Evaluate each measuring system using the criteria of: length, mass (weight), area, perimeter, circumference, and volume.	2, 3, 4	Science
(4) Apply the elements of the English/Imperial system and the metric system.	1, 2, 3, 4	SI – H – A1, A2, A3, A4, A5, A6
(5) Apply basic measurement systems' measurements to the mathematical operations of length, mass (weight), area, perimeter, circumference, and volume.	1, 2, 3, 4	Arts CE – 1VA-H2, H7 HP – 3VA-H4 CA – 4VA-H1, H3
C. ANNOTATING DRAWINGS		English Language Arts
(1) Identify notes, symbols, and the placement of notes and symbols.	1, 3, 1, 2, 3, 4	ELA 1—H1, H3, H4, H5 ELA 2—H4, H6 ELA 3—H1, H2, H3 ELA 4—H2, H5 ELA 5—H1, H2, H3, H4, H6 ELA 7—H1
(2) Prepare notes and proportionately sized symbols for features requiring description (e.g., electrical symbols).	1, 2, 3, 4	
(3) Apply annotation notes, symbols, and placement to correct the feature being described (e.g., electrical symbols).		
D. LINE STYLES AND WEIGHTS		Mathematics
(1) Identify line styles (e.g., center line, hidden line, phantom, object, section).	1, 3, 4 1, 3, 4	N – 1H, 2H, 3H, 4H, 5H, 6H, 7H A – 1H, 4H M – 1H, 2H, 3H, 4H G – 1H, 5H D—None P—None
(2) Identify line weights (e.g., center line, hidden line, phantom line, object line, section line).	1, 2, 3, 4 1, 2, 3, 4	
(3) Evaluate line styles and correct line style in order to represent/define features		
(4) Apply various line styles in accordance with industry-accepted standards.		

Benchmarks	Louisiana Foundation Skills	Academic Cross-Reference Standard-Benchmark
		Science SI –H – A1, A2, A3, A5, A6, A7 Arts CE – 1VA – H2, H7 AP – 2VA – H4 CA – 4VA—H1
E. PREPARING TITLE BLOCKS AND OTHER DRAFTING FORMATS		English Language Arts ELA 1—H1, H3, H4, H5
(1) Identify title block components (e.g., sale, sheet, number, revision). (2) Evaluate the title block using the following criteria: location on the drawing, content, and appropriate letter height and justification. (3) Prepare a title block. (4) Identify the components of a bill of materials, parts list, and schedules. (5) Prepare a title block including bill of materials, parts list and schedule. (6) Identify/prepare a tolerance block. (7) Reference/information chart, identify the size, quantity, symbol, and location of each feature and proprietary information. (8) Evaluate the tolerance block using the following criteria: location on the drawing, content, and appropriate letter height and justification. (9) Identify/prepare a revision status of sheet blocks. (10) Identify/prepare a border, incorporating fold lines, microfilm, arrows and zones. (11) Evaluate the border using the following criteria: location on the drawing, content, and appropriate letter height and justification. (12) Identify and apply industry standard symbols, identify the finish mark, electrical/electronic, welding, GD&T, machine tool, and architectural symbols	1, 3, 1, 2, 3, 4 1, 2, 3,4 1, 3, 4 1, 2, 3, 4 1, 2, 3, 4 1, 2, 3, 4 1, 2, 3, 4 1, 2, 3, 4 1, 2, 3, 4 1, 2, 3, 4 1, 2, 3, 4	ELA 2—H4, H6 ELA 3—H1, H2, H3 ELA 4—H2, H5 ELA 5—H1, H2, H3, H4, H6 ELA 7—H1 Mathematics N – 1H, 2H, 3H, 4H, 5H, 6H, 7H A – 1H M – 1H, 2H, 3H, 4H G – 1H, 5H D—None P—None Social Studies C – 1A –H1 E – 1A – H3 Science SI –H – A3 Arts CE – 1VA – H1, H2, H7 CA – 4VA—H1
F. REPRODUCTION OF ORIGINALS USING DIFFERENT METHODS	1, 3, 1, 2, 3, 4 1, 2, 3, 4	English Language Arts (ELA) ELA 1—H1, H3, H4, H5 ELA 2—H4 ELA 3—H1, H2, H3 ELA 4—H2, H5 ELA 5—H1, H2, H3, H4, H6 ELA 7—H1
G. CREATE FREEHAND TECHNICAL SKETCHES		Mathematics
(1) Identify the purpose of a freehand sketch. (2) Create freehand technical sketches.	1, 2, 3, 4 1, 2, 3, 4	N – 1H, 2H, 3H, 4H, 6H, 7H A – 3H M – 1H, 2H, 3H, 4H G – 1H, 2H, 3H, 4H, 5H, 6H D—None P—None
		Social Studies

Benchmarks	Louisiana Foundation Skills	Academic Cross-Reference Standard-Benchmark
		C-1A—H1
		Science SI –H – A1, A2, A3, A5, A6, A7
		Arts
		CE – 1VA – H1, H2, H5, H7
		AP – 2VA – H4
		CA – 4VA—H1, H3
H. ORTHOGRAPHIC PROJECTIONS		English Language Arts (ELA)
(1) Identify appropriate orthographic views to completely describe an object.	1, 2, 3, 4	ELA 1—H1, H3, H4, H5
(2) Identify the proper size and location of necessary orthographic views.	1, 2, 3	ELA 4—H2, H5
(3) Identify, create, and place appropriate orthographic views.	1, 2, 3, 4	ELA 5—H1, H2, H3, H4
(4) Create orthographic views utilizing the criteria: necessary views, surface and edge relationships, and hidden lines/surfaces.	1, 2, 3, 4	ELA 7—H1
(5) Identify, create, and place appropriate section views.	1, 2, 3, 4	Mathematics
(6) Identify the purposes of section views.	1, 2, 3, 4	N – 1H, 2H, 3H, 4H, 5H, 6H, 7H
(7) Create section views with (e.g., full, rib, half).	1, 2, 3, 4	A – 1H, 2H, 3H, 4H
(8) Identify, create, and place appropriate auxiliary views.	1, 2, 3, 4	M – 1H, 2H, 3H, 4H
(9) Identify the purposes of primary and secondary auxiliary views.	1, 2, 3, 4	G – 1H, 2H, 3H, 4H, 5H, 6H
(10) Identify primary and secondary auxiliary purposes for use.	1, 2, 3, 4	D—None
		P—None
		Social Studies
		C – 1A—H1, H2
		C-1A—H1
		Science
		SI –H – A1, A2, A3, A5, A6
		Arts
		CE – 1VA – H1, H2, H3, H7 CA – 4VA—H1 AP – 2VA – H4
I. PICTORIAL DRAWINGS		English Language Arts (ELA)
(1) Identify isometric, diametric, trimetric, and exploded drawings.	1, 2, 3	ELA 1—H1, H3, H4, H5
(2) Identify and create axonometric drawings.	1, 2, 3, 4	ELA 2—H4
(3) Create in detail axonometric; isometric, diametric, trimetric, and exploded drawings. Evaluate the drawings by the criteria: size and angle.	1, 2, 3, 4	ELA 4—H2, H5 ELA 5—H1, H2, H3, H4, H6
(4) Identify cabinet and cavalier oblique drawings.	1, 2, 3	ELA 7—H1
(5) Identify and create oblique and cavalier drawings.	1, 2, 3, 4	
(6) Create cabinet and cavalier oblique drawings, using proper size and angle.	1, 2, 3, 4	Mathematics
(7) Identify perspective drawings.	1, 2, 3	N – 1H, 2H, 3H, 4H, 5H, 6H, 7H
(8) Identify 1, 2, and 3-point views, evaluating different types of perspective drawings.	1, 2, 3, 4	M – 1H, 2H, 3H, 4H G – 1H, 2H, 3H, 4H, 5H, 6H

Benchmarks	Louisiana Foundation Skills	Academic Cross-Reference Standard-Benchmark
J. DIMENSIONING		P – None D – None
(1) Identify extension, dimension and leader lines from a drawing.	1, 3	
(2) Identify and describe generally accepted dimensioning practices (e.g., spacing, crossing lines).	1, 2, 3	Social Studies G – 1A—H1, H2
(3) Apply dimensioning rules to extension, dimension, and leader lines.	1, 2, 3	C – 1A—H1
(4) Identify and outline the use of generally accepted dimension line terminators.	1, 3	
(5) Identify the generally accepted practices of dimensioning a line, an angle, radii, and diameter.	1, 3	Science SI – H – A1, A2, A3, A4, A5, A6
(6) Apply the proper size and location to: dimensions of lines, arcs, angles, radii, and diameters.	1, 2, 3, 4	
(7) Identify the generally accepted practices of dimensioning spheres, cylinders, tapers, pyramids, irregular objects, and pictorial drawings.	1, 3, 4	Arts CE – 1VA – H1, H2, H3, H7
(8) Apply the proper size and location to spheres, cylinders, tapers, pyramids, irregular objects, and pictorial drawings.	1, 2, 3, 4	AP-2VA—H4 CA – 4VA – H1
(9) Identify the purpose of size and location of a center line for dimensioning symmetrical features.	1, 3	
(10) Apply the symmetrical features of a center line to its proper size and location.	1, 2, 3	
		English Language Arts (ELA)
(11) Identify and provide a use for different types of dimensioning style (e.g., Cartesian, polar, datum, coordinate).	1, 2, 3	ELA 1—H1, H2, H3, H4, H5
(12) Apply the proper size and location to Cartesian, polar, datum, and coordinate dimensioning methods.	1, 2, 3, 4	ELA 2—H4 ELA 3—H1, H2, H3
(13) Identify and place tolerance dimensioning and Geometric Dimensioning and Tolerance.	1, 2, 3, 4	ELA 4—H2, H5 ELA 5—H1, H2, H3, H4, H6
(14) Apply the proper size and location to GD &T (tolerancing and datum) symbols.	1, 2, 3, 4	ELA 7—H1
		Mathematics N – 1H, 2H, 3H, 4H, 5H, 6H, 7H A – 1H, 2H, 3H, 4H M – 1H, 2H, 3H, 4H
		G – 1H, 2H, 3H, 4H, 6H D – None P – None
		Social Studies C – 1A—H1
		Science SI – H – A1, A2, A3, A4, A5, A6
		Arts CE – 1VA – H1, H2, H7 CA – 4VA – H1

B. Standard 2. Fundamental Computer Skills

Benchmarks	Louisiana Foundation Skills	Academic Cross-Reference (Standard-Benchmark)
A. HARDWARE		English Language Arts (ELA)
(1) Demonstrate proper care of equipment for care of computer components.	1, 3	ELA 1—H1, H3, H4, H5 ELA 2—H4
(2) Explain the standard procedures regarding care of equipment: keyboard, monitor, CPU, etc., based on the survey of operators' manuals.	1, 3	ELA 4—H2, H5 ELA 5—H1, H2, H3 ELA 7—H1, H2
(3) Identify/explain standard procedures for input devices (mouse, keyboard, tablet/digitizer) based on the survey of the operators' manual.	1, 2, 3	Mathematics N – 4H, 5H A – 1H M – 4H G – 3H, 4H, 5H, 6H
(4) Operate and interface with computers and software through the use of input devices (e.g., mouse, keyboard, tablet/digitizer).	1, 2, 3	
(5) Identify and explain output devices (printers/plotters) based on the standard procedures found in the survey of operators' manuals.	1, 2, 3	Social Studies E – 1A—H3
(6) Operate and adjust output devices.	1, 2, 3	
(7) Identify different types of storage media and the proper operating methods/protection capabilities for each type.	1, 3	Science SI – H – A3, A5
(8) Explain the standard techniques and procedures for the care and usage of storage media (e.g., diskettes, tapes, CDs).	1, 3	Arts
(9) Demonstrate power-up with system function intact and initialization/exit procedures.	1, 3	CE – 1VA – H2
(10) Demonstrate the ability to adjust monitor controls. (e.g., brightness, contrast, etc.).	1, 2, 3	English Language Arts (ELA) ELA 1—H1, H3, H4, H5 ELA 2—H4, H6 ELA 3—H1, H2, H3 ELA 4—H2, H5 ELA 5—H1, H2 ELA 7—H1, H2
(11) Recognize availability of information services.	1, 2, 3, 4	
(12) Describe the purpose of e-mail, bulletin boards, internal/external computer networks, and online information services.	1, 3, 4	
B. PHYSICAL AND SAFETY NEEDS		
(1) Demonstrate an understanding of ergonomic considerations.	1, 2, 3, 4	Mathematics N – 3H, 4H, 5H, 6H, 7H M – 1H, 2H, 3H, 4H G – 1H, 2H, 3H, 4H, 5H, 6H P – 4H
(2) List and explain the importance of each feature of an ergonomic environment for a computer operator.	1, 2, 3, 4	
(3) Identify/explain ergonomic applications (e.g., lighting, posture, keyboard position).	1, 2, 3, 4	
(4) Demonstrate personal safety.	1, 3, 4	Social Studies C-1A—H1 E-1A—H3
(5) List safety standards and describe potential safety hazards that may affect a computer operator.	1, 3, 4	
(6) List and describe the OSHA and national Electrical Code safety standards, e.g., extension cords, daisy chaining, and watts usage for an outlet.	1, 3, 4	Science SI-H—A1, A2, A3, A5, A6, A7 S1-H—B3, B5 PS-H—G4
		Arts CE – 1VA – H2, H7 AP-2VA—H4 CA-4VA—H1
		English Language Arts (ELA)

Benchmarks	Louisiana Foundation Skills	Academic Cross-Reference (Standard-Benchmark)
		ELA 1—H1, H3, H4, H5
		ELA 2—H4, H6
C. OPERATING SYSTEMS		ELA 3—H1, H2, H3
(1) Start and exit software programs as required.	1, 3	ELA 4—H2, H5
(2) Demonstrate proper file management techniques.	1, 2, 3, 4	ELA 5—H1, H2, H3
(3) List and describe the function of file management commands.	1, 3, 4	ELA 7—H1
(4) Explain definitions and procedures for file management techniques: copying, deleting, finding, saving, and renaming.	1, 2, 3, 4	Mathematics N – 2H, 3H, 4H, 5H, 6H, 7H M – 1H, 2H, 3H, 4H G – 1H, 2H, 3H, 5H, 6H D – 7H
(5) Demonstrate definitions and procedures for file management techniques.	1, 3, 4	
(6) Explain and demonstrate formatting a floppy disk.	1, 2, 3	Social Studies E-1A—H3
(7) Identify, create, and use directory structure and change paths.	1, 2, 3	
(8) Identify the correct method to organize files on a particular workstation and recognize potential problems.	1, 2, 3	Science S1-H—A1, A2, A3, A5, A6, A7
(9) Create and apply a directory structure (e.g., directories, sub-directories, files) to organize files on a particular workstation.	1, 2, 3	Arts CE – 1VA – H7
(10) Identify, explain, and demonstrate the file back-up procedure for files, directories, programs, etc., based on the operating/application system.	1, 2, 3, 4	
(11) Translate, import, and export data files between formats.	1, 2, 3, 4	
(12) Explain the procedure and limitations for data files and data types based on the application system (i.e., justification, advantages and disadvantages).	1, 2, 3	
(13) Identify the location and purpose of online help.	1, 3, 4	
(14) Use an online help tutorial based on the application system.	1, 2, 3, 4 1,2, 3	
(15) Save drawings to storage devices such as hard drives, floppy disks, CDs, etc., based on the application system.		

C. Standard 3. Basic CADD Skills

Benchmarks	Louisiana Foundation Skills	Academic Cross-Reference (Standard-Benchmark)
A. CREATE		English Language Arts (ELA)
(1) Demonstrate the ability to open a drawing data file and create a drawing.	1, 2, 3	ELA 1—H1, H3, H4, H5
(2) Demonstrate the ability to perform a drawing setup (e.g., sheet size, border, title block).	1, 2, 3	ELA 2—H4 ELA 4—H2, H5
(3) Construct geometric figures through the use of multiple construction techniques. (e.g., lines, conics, circles, splines, arcs, polygons) given size, orientation, and location specifications.	1, 2, 3, 4	ELA 5—H1, H2, H3 ELA 7—H1 Mathematics
(4) Create text using appropriate style and size to annotate drawings.	1, 2, 3	N – 1H, 2H, 3H, 4H, 5H, 6H, 7H
(5) Use and control accuracy enhancement tools such as snap, grid, construction plane, etc.	1, 2, 3	A – 3H, 4H M – 1H, 2H, 3H, 4H

(6) Use and control entity positioning tools osnap, snap, grid, construction plane, etc.	1, 2, 3	G – 1H, 2H, 3H, 4H, 5H, 6H
(7) Identify, create, store, and use appropriate symbols/libraries.	1, 2, 3, 4	Social Studies
(8) Identify and differentiate between various symbol styles: ANSI standard, ISO standard, company standards, and discipline oriented symbols.	1, 2, 3, 4	C-1A—H1
(9) Demonstrate the ability to retrieve symbols from a defined location. (10) Demonstrate the ability to locate, size, and orient documentation symbols.	1, 2, 3, 4 1, 2, 3, 4	Arts CE – 1VA – H2, H7
(11) Create accurate and proper 3D wireframe/solid representations for plane services.	1, 2, 3	
(12) Create accurate and properly represented 3D solid models composed of primitives.	1, 2, 3, 4	
(13) Extract an accurate 2D profile from a 3D wireframe model.	1, 2, 3, 4	
(14) Revolve a profile to create a 3D object. (15) Create 3D wireframe models from 2D geometry using extrusions.	1, 2, 3, 4 1, 2, 3, 4	
B. EDIT (1) Identify and define the editing commands: mirror, trim, extend, scale, rotate, etc., which are used as techniques for construction.	1, 3, 4	English Language Arts (ELA) ELA 1—H1, H3, H4, H5 ELA 2—H4
(2) Demonstrate an accurate and unambiguous representation of an object utilizing the editing commands: mirror, trim, extend, scale, rotate, etc.	1, 2, 3	ELA 3—H1 ELA 4—H2, H5
(3) Identify non-geometric entities such as text, title blocks, fonts, attributes, annotations, color, and dimensions.	1, 2, 3	ELA 5—H1, H2, H3, H4 ELA 7—H1
(4) Demonstrate editing and sizing skill utilizing non-geometric commands: text sizing, editing, font, and orientation.	1, 2, 3, 4	
		Mathematics
		N – 2H, 3H, 4H, 5H, 6H, 7H A – 1H, 2H, 3H, 4H M – 1H, 2H, 3H, 4H
		G – 1H, 2H, 3H, 4H, 5H, 6H
		Social Studies
		C-1A—H1
		E-1A—H3
		Science SI-H – A1, A2, A3, A5, A6, A7 S1-H—B3
		Arts CE – 1VA – H2, H7 CA – 4VA – H1
C. MANIPULATE		English Language Arts (ELA)
(1) Identify coordinate type, origin, scale, axis orientation, and origin locations. (2) Demonstrate the modification and selection of origin, scale, and axis orientation.	1, 3 1, 2, 3	ELA 1—H1, H3, H4, H5 ELA 2—H4 ELA 3—H1
(3) Identify line style properties and types such as color, thickness, style, etc. (4) Demonstrate the modification of entity properties (e.g., color type, line type, thickness type).	1, 3 1, 2, 3	ELA 4—H2, H5 ELA 5—H1, H2, H3, H4 ELA 7—H1
(5) Demonstrate viewing commands (e.g., dynamic rotation,	1, 2, 3	

zooming, panning, change view, view names, multiview-view). (6) Define and apply the correct use for display commands (e.g., hidden line, no hidden, shading, meshing, wire frame, etc.).	1, 2, 3	Mathematics N – 1H, 2H, 3H, 4H, 5H, 6H, 7H A – 1H, 2H, 3H, 4H
(7) Define and identify standard parts and symbol libraries (e.g., scale, location, entity properties).	1, 2, 3, 4	M – 1H, 2H, 3H, 4H G – 1H, 2H, 3H, 4H, 5H, 6H
(8) Demonstrate the location, use, and creation of standard parts and symbol libraries (e.g., scale, location, entity properties).	1, 2, 3, 4	Social Studies C – 1A—H1
(9) Plot drawings on media using correct layout and scale.	1, 2, 3, 4	E – 1A—H3
(10) Define and understand the various purposes and usage of layering techniques (e.g., freeze, visibility).	1, 2, 3	Science SI-H – A1, A2, A3, A5, A6, A7
(11) Demonstrate and apply the various laying techniques (e.g., freeze, visibility).	1, 2, 3, 4	SI- H –B3
(12) Define and understand the various purposes and the use of grouping techniques (e.g., ungroup, delete, regroup, create).	1, 2, 3	Arts
(13) Demonstrate various grouping techniques.	1,2, 3	CE – 1VA – H2, H7
(14) Determine file size/extraneous entities and the need for file size reduction.	1, 2, 3	CA – 4VA—H1
(15) Demonstrate reduction of file size/extraneous entities.	1, 2, 3, 4	
D. ANALYZE		
(1) Use query commands to interrogate database.	1, 2, 3, 4	
(2) Apply the use of query commands (e.g., mass properties, geometric measure, system status, entity characteristics).	1, 2, 3	
E. DIMENSIONING		English Language Arts (ELA)
(1) Correctly identify and define the various descriptors of associative dimensioning (e.g., horizontal, vertical, ordinate).	1, 2, 3	ELA 1—H1, H3, H4, H5 ELA 2—H4
(2) Demonstrate the various descriptors of associative dimensioning (e.g., horizontal, vertical, ordinate).	1, 2, 3, 4	ELA 3—H1, H2, H3 ELA 4—H2, H5 ELA 5—H1, H2, H3
		ELA 7—H1
		Mathematics N – 1H, 2H, 3H, 4H, 5H, 6H, 7H A – 1H, 2H, 3H, 4H
		M – 1H, 2H, 3H, 4H
		G – 1H, 2H, 3H, 4H, 5H, 6H
		Social Studies
		C-1A—H1
		E-1A—H3
		Science
		S1-H—A1, A2, A3, A5, A6, A7
		Arts
		CE – 1VA—H2, H7
		CA-4VA—H1

D. Standard 4. Advanced CADD Skills

Benchmarks	Louisiana Foundation Skills	Academic Cross-Reference (Standard-Benchmark)
A. CREATE WIREFRAME AND/OR SOLID MODELS		English Language Arts (ELA)
(1) Create multiple radii fillets, sculpted surfaces, variable	1, 2, 3	ELA 1—H1, H3, H4, H5

fillets, complex/compound wireframe or solid 3-D models.		ELA 2—H4
(2) State the difference between analytic and non-analytic surfaces; define NURBS, B-spline, Gordon, Coons patch, etc.	1, 3, 4	ELA 3—H1, H2, H3 ELA 4—H2, H5
(3) Create non-analytic surfaces using appropriate modeling.	1, 2, 3	ELA 5—H1, H2, H3
(4) Define conics, cylinders, revolved ruled tabulated surfaces, etc.	1, 2, 3	ELA 7—H1
(5). Create analytic surfaces using modeling with planes and analytic curves.	1, 2, 3	
(6). Create offset surfaces at a specified distance.	1, 2, 3	Mathematics
(7). Find an intersection of two surfaces through a show of lines or curves at the intersection of surfaces.	1, 2, 3	N – 1H, 2H, 3H, 4H, 5H, 6H, 7H A – 1H, 2H, 3H, 4H
(8) Create joined surfaces, single surface, from multiple surfaces.	1, 2, 3	M – 1H, 2H, 3H, 4H
(9) Create a fillet or blend between two surfaces.	1, 2, 3	G – 1H, 2H, 3H, 4H, 5H, 6H
(10) Identify various types of feature-based geometry (e.g., holes, slots, round, fillets, counterbores, countersink, spotfaces).	1, 3	Social Studies
(11) Create various types of feature-based geometry based on size and location using features (e.g., holes, slots, round, fillets, counterbores, countersink, spotfaces).	1, 2, 3, 4	C-1A—H1 E-1A—H3
(12) Create and show sections of various types of styles of 3-D solid model sections (e.g., full, offset, rotates, half).	1, 2, 3, 4	Science S1-H—A1, A2, A3, A5, A6, A7
(13) Construct and label exploded assembly drawings of multiple models.	1, 2, 3, 4	
(14) Demonstrate mastery of advanced Boolean operations; keep model database small (e.g., multiple union, subtraction, intersection, instancing).	1, 2, 3, 4	Arts CE – 1VA—H2, H7
		CA-4VA—H1
B. EDIT WIREFRAME AND/OR SOLID MODELS		English Language Arts (ELA)
(1) Demonstrate mastery or trimming surfaces, including multiple trimmed surfaces.	1, 2, 3, 4	ELA 1—H1, H3, H4, H5 ELA 2—H4
(2) Demonstrate mastery of manipulating surface normals, including reverse and reverse normal.	1, 2, 3, 4	ELA 3—H1, H2, H3 ELA 4—H2, H5
(3) Demonstrate mastery of skill by extending surfaces.	1, 2, 3, 4	ELA 5—H1, H2, H3
(4) Define, identify, and edit control points of various non-analytical surface (e.g., Bezier, mesh, NURBS, Coons Patch).	1, 2, 3, 4	ELA 7—H1
(5) Demonstrate skill and modify surface by adding and/or removing the control point (e.g., Bezier, mesh, NURBS, Coons Patch).	1, 2, 3, 4	Mathematics N – 1H, 2H, 3H, 4H, 5H, 6H, 7H
(6) Demonstrate skill by deleting solid primitives.	1, 2, 3, 4	A – 1H, 2H, 3H, 4H
(7) Demonstrate skill by moving, copying, and resizing primitives.	1, 2, 3, 4	M – 1H, 2H, 3H, 4H
C. MANIPULATE WIREFRAME AND/OR SOLID MODELS		G – 1H, 2H, 3H, 4H, 5H, 6H
(1) Perform and axis new clipping using a plane to display desired pre-determined view, including hidden line removal.	1, 2, 3, 4	Social Studies
(2) Extract wireframe data from surface/solid geometry data to create a 3-D wireframe from a 3-D model.	1, 2, 3, 4	C-1A—H1E-1A—H3
(3) Identify the purposes and uses of rendering a model's image as far as its reflectivity, opacity, light source, and material finishes.	1, 2, 3, 4	

(4) Define <i>reflectivity, opacity, light source, type, and material finishes</i> . (5) Shade a rendered image of a model or object using reflectivity, opacity, and lights.	1, 2, 3, 4 1, 2, 3, 4	Science S1-H—A1, A2, A3, A5, A6, A7
(6) Render an image of the model or object using material properties and finishes.	1, 2, 3, 4	
		Arts CE – 1VA—H2, H7 CA-4VA—H1
D. ANALYZE A WIREFRAME AND/OR SOLID MODEL (1) Identify the purposes and uses of extracting geometric data from surfaces and a wireframe.	1, 2, 3, 4	English Language Arts (ELA) ELA 1—H1, H3, H4, H5 ELA 2—H4
(2) Extract valid and usable geometric data from surfaces and a wireframe.	1, 2, 3, 4	ELA 3—H1, H2, H3
(3) Identify the purposes and uses of attribute data. (4) Demonstrate ability to completely extract lists, files, and valid and usable attribute data from parts lists and bills of materials.	1, 2, 3, 4 1, 2, 3, 4	ELA 4—H2, H5 ELA 5—H1, H2, H3 ELA 7—H1
(5) Identify gaps in non-intersecting surfaces. (6) Identify problems associated with surface-to-surface gaps in a database.	1, 2, 3, 4 1, 2, 3, 4	Mathematics
(7) Verify the existence of gaps, identify gaps in surfaces, and explain causes of gaps or non-intersection between surfaces.	1, 2, 3, 4	N—1H, 2H, 3H, 4H, 5H, 6H, 7H
(8) Demonstrate mastery of skill by locating and querying surface-to-surface gaps.	1, 2, 3, 4	A—1H, 2H, 3H, 4H
(9) Identify and define different kinds of surface properties (e.g., area, perimeter, normals).	1, 2, 3, 4	M—1H, 2H, 3H, 4H G—1H, 2H, 3H, 4H, 5H, 6H
		Social Studies C-1A—H1 E-1A-H3 Science SI-H—A1, A2, A3, A4, A5, A6, A7 Arts CE-1VA-H2, H7 CA-4VA—H1
		English Language Arts (ELA)
(10) Identify the purposes and uses of data extracted from surface properties (e.g., area, perimeter, normals).	1, 2, 3, 4	ELA 1—H1, H3, H4, H5 ELA 2—H4
(11) List and define the purposes of mass properties, such as moments of inertia, centroids, volume, and mass.	1, 3, 4	ELA 3—H1, H2, H3 ELA 4—H2, H5
(12) Demonstrate mastery of skill by extracting mass properties such as moments of inertia, centroids, volume, and mass.	1, 2, 3, 4	ELA 5—H1, H2, H3 ELA 7—H1
E. PRODUCTIVITY AND WORK HABITS (1) Identify the features that can be customized (e.g., menus, script files, macros, key assignments).	1, 3	Mathematics N – 1H, 2H, 3H, 4H, 5H, 6H, 7H
(2) Identify the purposes, uses, and needs for customization techniques in menus, key assignments, scripts, and macros.	1, 3	A – 1H, 2H, 3H, 4H M – 1H, 2H, 3H, 4H
(3) Perform customization to improve productivity (e.g., customize menus, function keys, script files, macros).	1, 2, 3	G – 1H, 2H, 3H, 4H, 5H, 6H
(4) Demonstrate results from applying customization techniques to menus, key assignments, scripts, and macros.	1, 2, 3	Social Studies C-1A—H1

(5) Identify non-graphical data, then define the purpose and describe the techniques for inputting or extracting non-graphical data.	1, 2, 3	E-1A—H3
(6) Identify the purpose and usage of non-graphical data.	1, 3	Science S1-H—A1, A2, A3, A5, A6, A7
(7) Demonstrate skill by manipulating non-graphical data.	1, 2, 3	
(8) Define standard drawing defaults and identify the purpose of changing system defaults.	1, 3, 4	Arts
(9) Identify the needs and purposes of drawing standard presets using template and library defaults.	1, 3, 4	CE – 1VA—H2, H7 CA-4VA—H1
(10) Demonstrate skill by using template and library system defaults to create drawing standard presents.	1, 2, 3, 4	
(11) Identify the need to construct geometry graphics using parametrically controlled programs.	1, 3, 4	
(12) Develop geometry using parametric programs.	1, 2, 3, 4	

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10) and R.S. 17:10.

HISTORICAL NOTE: Promulgated by the Department of Education, Board of Elementary and Secondary Education, Trade and Industrial Education, LR 31:

Subpart 5. Electricity

Chapter 15. Electrical Excellence Rationale

§1501. Introduction

A. See Subpart 1 of this Part XCIX for General Provisions applicable to this Electricity Skills Program.

B. The purpose of this Subpart 11 is to provide Louisiana administrators, supervisors, and instructors with electrical standards and benchmarks that can be used to improve the quality of instruction in Louisiana's Secondary Electrical Trade and Industrial Education Programs. A requirement of this project was to incorporate and reference appropriate, nationally approved standards and benchmarks. The national standards and benchmarks referenced in this work were developed under the auspices of the U. S. Electrical Construction Industry Skill Standards Certification Project. The project was undertaken as a cooperative agreement between the U. S. Department of Labor and a coalition of organizations representing the electrical construction industry. Those organizations that chose to participate in the project included the National Electrical Contractors Association, the Independent Electrical Contractors Association, the International Brotherhood of Electrical Workers and the National Joint Apprenticeship Training Committee. The goal of the Skill Standards project was to preserve high standards for electrical workers and to encourage formal acceptance of the standards by the entire electrical industry. The Louisiana State Apprenticeship Council, Louisiana Department of Labor, adopted these standards on October 18, 1996.

C. Electrical trade training in Louisiana may be obtained through selected public education programs at the high school level and the Louisiana Technical and Community College System, and through organizations such as the International Brotherhood of Electrical Workers and the Associated Builders and Contractors. The National Joint Apprenticeship Training Council defines electrical construction workers as those who are "electrically wiring single family homes, duplexes, commercial buildings, high-rise complexes, hospitals, schools, large factories, industries, even the huge electrical power generating plants that provide electric energy." Jobs within the electrical trades include both new construction and electrical maintenance and service.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10) and R.S. 17:10.

HISTORICAL NOTE: Promulgated by the Department of Education, Board of Elementary and Secondary Education, Trade and Industrial Education, LR 31:

Chapter 17. U.S. Electrical Construction Industry Trades Skill Standards and Certification

§1701. Safety

- A. General Jobsite Safety Awareness:
 - 1. list reasons why safety is important;
 - 2. identify key factors involved with safe work practices;
 - 3. develop respect for electricity:
 - a. be aware of dangers of shock;
 - b. describe locations of potential shock hazards;
 - c. demonstrate use of no contact voltage indicators and other devices to determine if system is energized;
 - d. demonstrate techniques for working on energized circuits;
 - 4. identify on the job hazards created by poor housekeeping;
 - 5. maintain safe work area and tool usage;
 - 6. be aware of the dangers of falling objects;
 - 7. respect and obey job safety.
- B. Emergency Procedures:
 - 1. first aide training;
 - a. general;
 - b. electrical shock situations;
 - 2. CPR;
 - 3. means to effect emergency rescues.
- C. Compliance with Osha and Epa Regulations:
 - 1. attend and/or conduct regular safety meetings;
 - 2. perform general OSHA requirements on the jobsite;
 - 3. practice guidelines for OSHA Assured Equipment Grounding and GFCI usage;
 - 4. use material safety data sheets (MSDS) to identify and properly handle hazardous materials (e.g., cleaning fluids, transformer oils).
- D. Substance Abuse:
 - 1. identify kinds and effects of drugs;
 - 2. identify and explain situations concerning substance abuse;
 - 3. identify sources of information and help.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10) and R.S. 17:10.

HISTORICAL NOTE: Promulgated by the Department of Education, Board of Elementary and Secondary Education, Trade and Industrial Education, LR 31:

§1703. Tools, Materials and Handling

- A. Proper Tool Management:
 - 1. identify common hand and power tools;
 - 2. proper selection and application of hand tools;
 - 3. proper selection and application of power tools;
 - 4. proper care for tools;
 - 5. safe techniques for using ladders;
 - 6. defects that make tools unsafe to use;
 - 7. use of meters to take readings

- B. Proper Rigging Methods:
 - 1. proper knots;
 - 2. proper techniques for rigging and hoisting;
 - 3. safe capacities for lifting arrangements.
- C. Proper Digging Techniques:
 - 1. depth and shape of holes for supporting poles;
 - 2. proper techniques for digging, grading and leveling trenches for the installation of duct work.
- D. Proper Use of Motorized Tools (Use of platform lifts, bucket truck, and truck mounted cranes)
- E. Proper Material Management:
 - 1. identify commonly used materials by name;
 - 2. proper selection and application of materials.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10) and R.S. 17:10.

HISTORICAL NOTE: Promulgated by the Department of Education, Board of Elementary and Secondary Education, Trade and Industrial Education, LR 31:

§1705. Math

- A. Appropriate Mathematical Calculations to Solve for Unknowns:
 - 1. arithmetic cooperators;
 - 2. solving word problems;
 - 3. problems involving fractions;
 - 4. reducing fractions to lowest terms;
 - 5. converting decimals to fractions and back;
 - 6. angles and sides of triangles;
 - 7. unknown angles and sides of triangle;
 - 8. metric prefixes and converting different prefixes;
 - 9. using powers of ten to perform math functions;
 - 10. converting from English to metric measurement systems;
 - 11. algebraic formulas ;
 - 12. square roots;
 - 13. ratio, percentages, and proportion;
 - 14. problems using direct and inverse relationships.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10) and R.S. 17:10.

HISTORICAL NOTE: Promulgated by the Department of Education, Board of Elementary and Secondary Education, Trade and Industrial Education, LR 31:

§1707. Electrical Theory

- A. Basic Electrical Theory:
 - 1. define terms, units of measure;
 - 2. electron flow;
 - 3. producing electrical current;
 - 4. products (effects) of electrical current.
- B. Ohm's Law, Kirchoff's Laws, Lenz's Law, Thevenin's And Nortons' Theorems
- C. Series Circuits:
 - 1. components;

2. resistance of circuits;
 3. total resistance;
 4. effects of changing voltage and resistance;
 5. law of proportion for series voltage divider circuits;
 6. power used in circuits:
 - a. by components;
 - b. wasted powers.
- D. Parallel Circuits
1. components;
 2. differences between series and parallel circuits;
 3. Ohm's Law;
 4. circuits;
 5. total resistance using product-sum and reciprocal methods;
 6. alternate current paths;
 7. currents ;
 8. law of proportion;
 9. power requirements of components.
- E. Combination Circuits:
1. combination circuits;
 2. components;
 3. equivalent resistance;
 4. alternate current paths;
 5. Ohm's Law;
 6. power use and dissipation.
- F. Characteristics of Voltages in Circuits:
1. polarity and flow of electrons;
 2. distribution and voltage drops;
 3. proper wire size needed to lower losses.
- G. Characteristics of Magnetism/Electromagnetism
- H. Theory of Superposition and Solving for Multiple Voltage Source Circuits
- I. Operation and Characteristics of Three Wire Systems
- J. Operation and Characteristics of Three Phase Systems:
1. identify differences between three wire single phase and three phase circuits;
 2. identify differences between voltage drop and power loss.
- K. AC Theory:
1. terms associated with AC theory;
 2. currents and voltages for components and circuits;
 3. conductor size using NEC;
 4. current and voltage sine waves to demonstrate phase relationship;
 5. maximum, effective (rms), average, and peak-to-peak voltage and current;
 6. inductance:
 - a. factors that affect inductance;
 - b. behavior of current when inductance is present;
 - c. relationship between current, applied voltage, and counter electromotive force;

- d. inductive reactance when frequency and inductance are known;
 - e. inductance, inductive reactance, and unknowns in various circuits;
- 7. capacitance:
 - a. effects on circuits of capacitance;
 - b. capacitance, capacitive reactance, and frequency;
- 8. relationships and behaviors of the following circuits:
 - a. series RL;
 - b. parallel RL;
 - c. series RC;
 - d. parallel RC;
 - e. series LC;
 - f. parallel LC;
 - g. series LCR; and
 - h. parallel LCR
- 9. function, operation and characteristics of rectifiers;
 - a. actions of full-wave and half-wave rectifiers;
 - b. schematics;
- 10. series resonance, parallel resonance and circuits;
- 11. filters;
- 12. power factor;
 - a. watts, vars and volt-amperes;
 - b. reactive power;
 - c. proper placement of power factor correction capacitors;
 - d. procedure to recognize and correct poor power factor arrangements;
- 13. power quality issues:
 - a. causes of poor power quality;
 - b. the effects of harmonics;
 - c. locating harmonics through observation and test equipment;
 - d. techniques to reduce or eliminate effects of harmonics.
- L. Use of Electronics:
 - 1. electron flow through solid-state components;
 - 2. precautions against electrostatic discharges around semiconductor devices;
 - 3. functions, operation and characteristics of diodes and zener diodes:
 - a. characteristic curves;
 - b. testing Procedures;
 - c. schematics including diodes;
 - 4. functions, operation and characteristics of transducers:
 - a. operation of transducers;
 - b. schematics including transducers;
 - 5. functions, operation and characteristics of various types of transistors (diacs, triacs, SCRs, etc.):
 - a. operation of transistors;
 - b. current and voltage values;
 - c. testing procedures;

- d. schematics including transistors;
- 6. functions, operations, characteristics and circuit configurations of amplifiers:
 - a. basic circuit configurations for various types of amplifiers;
- 7. functions, operations and characteristics of integrated circuits (ICs):
 - a. schematics of and including ICs;
 - b. information on data sheets for integrated circuits;
- 8. functions, operations and characteristics of three main categories of photo-operated devices;
- 9. digital and logic circuits:
 - a. terms associated with digital and logic circuits;
 - b. types of circuits;
 - c. the operative symbols for AND, OR, NOT operations;
 - d. the use of Boolean Algebra equations, laws, operations and theorems;
 - e. truth tables from Boolean equations and digital switching circuits;
 - f. gate functions and gate circuits;
 - g. BUFFER and INVERTER amplifiers and accompanying truth tables;
 - h. operation and characteristics of NAND and NOR logic and accompanying truth tables;
 - i. operation and characteristics of XOR and XNOR logic and accompanying truth tables;
 - j. positive and negative logic and its effect on gate operation;
 - k. digital logic equivalent circuits;
 - l. various optoelectronic devices.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10) and R.S. 17:10.

HISTORICAL NOTE: Promulgated by the Department of Education, Board of Elementary and Secondary Education, Trade and Industrial Education, LR 31:

§1709. Code Requirements

- A. National Electrical Code and Local Codes:
 - 1. purpose and intent of electrical codes;
 - 2. scope of NEC and local codes;
 - 3. how local codes may differ from NEC;
 - 4. utilizing code book:
 - a. mandatory rules;
 - b. fine print rules;
 - c. “neat and workmanlike”;
 - d. locate definitions;
 - e. interpretations;
 - f. recognize and use exceptions;
 - g. materials recognized by the NEC;
 - h. identify code markings;
 - i. distinguish wet, damp and dry locations;
 - j. determine if specific installations are acceptable to the Code;

- k. requirements for special occupancies and special equipment;
 - l. answer specific questions;
 - 5. use NEC to calculate various general job requirements:
 - a. service conductors, feeders, branch circuits;
 - b. permissible loads on various circuits;
 - c. allowable cable tray fills;
 - d. ampacity of various conductors and fill situations;
 - e. ampacity of various circuits and load types;
 - f. overload protection for motors, equipment and phase converters;
 - g. minimum ampacity for motor disconnecting means;
 - h. horsepower ratings for motors and disconnecting means;
 - i. grounding requirements;
 - 6. use NEC for hazardous locations:
 - a. hazardous locations by Class;
 - b. equipment and wiring methods necessary for particular hazardous

locations.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10) and R.S. 17:10.

HISTORICAL NOTE: Promulgated by the Department of Education, Board of Elementary and Secondary Education, Trade and Industrial Education, LR 31:

§1711. Conductors

- A. Various Types of Conductors:
 - 1. types of conductors and insulators;
 - 2. why some materials are better conductors or insulators than others;
 - 3. effect of heat on insulators;
 - 4. sizing and typing of conductors:
 - a. use letter symbols to identify insulator types;
 - b. use American Wire Gauge chart and convert inches, mils, square mils, and circular mils from one to the other;
 - 5. differences between aluminum and copper conductors;
 - 6. properties of high voltage cable;
 - 7. effects of soil conditions on underground cable.
- B. Conductor Installation Techniques:
 - 1. different wiring methods for particular conductors and situations:
 - a. wire connectors;
 - b. types, installation, limitations;
 - 2. different methods of installing conductors in conduits, raceways and cable trays:
 - a. problems which may be encountered;
 - b. maximum tension allowed;
 - c. use of pulling machines to assist in installation of wire;
 - 3. proper splicing methods and techniques for various conductors and locations.
- C. Methods for Selecting Conductors:
 - 1. using Code to determine type of conductor to use in particular situation;

2. using mathematical calculations to determine current carrying capacity of conductors;
3. calculating or selecting cable ampacity from NEC tables;
4. loads for sizing conductors;
5. code requirements depending on types of circuits and loads (lighting, appliance, heating, service entrance).

D. Cable Fault Situations:

1. the types and causes of cable faults;
2. methods and equipment for locating cable faults, including terminal, tracing and magnetic detection.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10) and R.S. 17:10.

HISTORICAL NOTE: Promulgated by the Department of Education, Board of Elementary and Secondary Education, Trade and Industrial Education, LR 31:

§1713. Conduit, Raceways, Panelboards and Switchboards

A. Terms Associated with Conduits and Raceways

B. Conduit and Wiring Support Systems Recognized by Code:

1. select appropriate conduit type;
2. select and utilize appropriate connectors;
3. select and utilize appropriate fastening devices and reinforcements;
4. special considerations.

C Procedures for Laying out Various Types of Bends:

1. take-up and gain;
2. kicks and offsets;
3. calculate degrees;
4. back-to-back bends;
5. determine overall length of conduit for specific situations;
6. locating bending points;
7. four techniques for segment bending;
8. techniques and operations for making concentric bends;
9. radius of circle.

D. Procedures for Making Bends when Fabricating Conduits:

1. hand benders to make on small diameter conduit;
2. power benders to make bends on larger diameter pipe:
 - a. make offset using “constants” or “shrink” methods;
 - b. make bends in proper sequence, direction and with necessary

accuracy.

E. Fabricating Raceways and Wiring Support Systems

F. Cable Assembly Wiring Method Recognized By The Code:

1. installation of panels;
2. installation of components;
3. wiring and connections;
4. special considerations and occupancies.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10) and R.S. 17:10.

HISTORICAL NOTE: Promulgated by the Department of Education, Board of Elementary and Secondary Education, Trade and Industrial Education, LR 31:

§1715. Lighting Systems

A. Function, Operation, and Characteristics of Various Lighting Systems:

1. incandescent;
2. florescent;
3. HID;
4. low voltage.

B. Lighting Distribution and Layout

C. Installation and Connection of Fixtures

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10) and R.S.

17:10.

HISTORICAL NOTE: Promulgated by the Department of Education, Board of Elementary and Secondary Education, Trade and Industrial Education, LR 31:

§1717. Overcurrent Devices

A. Function, Operation, and Characteristics of Overcurrent Protection Devices:

1. purpose and location of devices;
2. three considerations necessary for electrical component protection;
3. interrupting ratings;
4. short circuit currents;
5. overload and overcurrent situations;
6. 10 and 25 foot tap rules;
7. operation and application of fuses:
 - a. dingle element and time delay;
 - b. the effects of heat;
8. operation and application of various types of circuit breakers (e.g., molded case, air break);
9. utilize Peak-Let-Thru charts and table;
10. function, operation, and characteristics of ground fault circuit interrupters;
11. function, operation, and characteristics of surge protectors;
12. appropriate devices for situation and according to Code.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10) and R.S.

17:10.

HISTORICAL NOTE: Promulgated by the Department of Education, Board of Elementary and Secondary Education, Trade and Industrial Education, LR 31:

§1719. Grounding Systems

A. Function, Operation and Characteristics of Grounding Systems:

1. reasons for grounding systems;
2. general types of faults;
3. grounding electrode systems.

B. Sizing, Layout and Installation of Grounding Sytems:

1. NEC requirements and interpretations;
2. size of conductors and electrodes;
3. installation of electrodes;
4. installation of conductors and connections to electrodes;
5. the impact of soil conditions on earth grounding systems and equipment;

- 6. principles and procedures of earth resistance testing;
- 7. determine when ground fault protection is required.
- C. Difference between Insulation, Isolation, and Elevation
- D. Difference between Grounding, Grounded, and Bonding
- E. Special Circumstances:
 - 1. systems over 1,000 volts;
 - 2. separately derived systems;
 - 3. buildings sharing service.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10) and R.S. 17:10.

HISTORICAL NOTE: Promulgated by the Department of Education, Board of Elementary and Secondary Education, Trade and Industrial Education, LR 31:

§1721. Prints and Specifications

- A. Creation of Blueprints, Plans, and Specifications:
 - 1. utilize symbols used in electrical and related trades;
 - 2. recognize functions of basic line types;
 - 3. identify drawing tools and techniques:
 - a. orthographic views;
 - b. types of projections;
 - c. drafting scales;
 - 4. recognize and apply dimensions;
 - 5. prepare “as-built” drawings;
 - 6. differences between wiring diagrams, line drawings, schematics and ladder diagrams:
 - a. given schematics complete wiring diagrams;
 - b. given panels and equipment layouts create drawings showing conduits and conductors using appropriate scale.
- B. Use of Blueprints, Plans, and Specifications:
 - 1. recognize function of various types of plots, sections, details, schedules, specification sheets, addenda, and revisions;
 - 2. determine devices, locations, quantities, feeds, conduit types and sizes and conductor sizes:
 - a. parts of the electrical service;
 - b. identifying special purpose outlets and the loads they serve;
 - c. completing take-off sheets for ordering material;
 - d. determine costs for jobs;
 - e. how costs affect job;
 - 3. interpret non-electrical dimensions and considerations;
 - 4. relationships between architectural considerations and electrical installations;
 - 5. correlate information from other trades plans with electrical plans to determine potential conflicts.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10) and R.S. 17:10.

HISTORICAL NOTE: Promulgated by the Department of Education, Board of Elementary and Secondary Education, Trade and Industrial Education, LR 31:

§1723. Motors, Motor Controllers and Process Controllers

A. Function, Operation, and Characteristics of Various Types of Motors (AC, DC, Dual Voltage, Repulsion, Universal, 3-Phase, Squirrel Cage, Synchronous):

1. physical parts of various motors;
2. utilize information sheets, plans, schematics, and motor nameplates to gain information;
3. motor losses;
4. starting and operating characteristics;
5. methods to identify windings in DC motors;
6. means for providing for field failure, current limit, voltage and speed control;
7. block diagrams to demonstrate power supplies, armature, field and control features;
8. torque, locked rotor current, no-load speed, and slip;
9. reasons for low-voltage starting;
10. function, operation, and characteristics of stepping motors.

B. Proper Techniques for Motor Installations:

1. necessary calculations for electrical requirements per Code;
2. correct power factor;
3. proper wire type and size;
4. appropriate connections;
5. how various motors can be made to run at different speed or in reverse direction:
 - a. schematics;
 - b. connections to reverse or change speeds;
6. identify unmarked motor leads;
7. steps for proper handling of motors:
 - a. checks for mechanical defects;
 - b. factors to be checked when a motor arrives at jobsite;
 - c. methods for putting motor into storage.

C. Function, Operation, and Characteristics of Motor Controllers, Circuits and Devices:

1. ways and means of starting and stopping motors;
2. operation of magnetic coil;
3. use of magnetic starters and controllers;
4. correct sizing of magnetic starters and controllers;
5. difference between starters and controllers;
6. function, operation, and characteristics of overload protective devices:
 - a. thermal overload;
 - b. magnetic overload;
7. schematics for various control circuits;
8. two-wire control circuits;
9. three-wire control circuits;
10. interlocking methods;
11. reversing and sequential controllers;
12. jogging, inching, plugging;

13. multiple start-stop controls and selector switches;
14. phase failure relays;
15. various manual and automatic speed control techniques;
16. function, operation, and characteristics of variable frequency drives;
17. function, operation, characteristics, and installation procedures for programmable logic controls:
 - a. function of central processing unit;
 - b. memory types and sizes;
 - c. user and storage memory;
 - d. back-up batteries;
 - e. peripheral devices;
18. ladder diagrams;
19. function, operation, and characteristics of timers, counters, sequencers;
20. utilize appropriate manuals and information for start-up, maintenance and testing;
21. utilize schematics for manual starters, automatic starters, speed regulators and controllers.

- D. Function, Operation, and Characteristics of Switches and Relays:
1. schematics including switches and relays;
 2. installation and connection methods for various switch types;
 3. installation and connection methods for various relays;
 4. function, operation, and characteristics of electronic sensor and pilot devices;
 5. function, operation, and characteristics of control transformers:
 - a. leads of control transformers;
 - b. proper sizing of control transformers.

- E. Mechanical Connections to Utilize Motors:
1. operation of mechanical clutches and magnetic drives;
 2. direct and offset drives;
 3. proper pulley sizes required.

- F. Process Control System and Devices:
1. operating requirements followed by manual and automatic controllers;
 2. function, operation, characteristics, and installation of:
 - a. closed loop and open loop systems;
 - b. feedback control;
 - c. proportional control;
 - d. integral control;
 - e. derivative control;
 3. block diagrams including control systems and devices;
 4. function, operation, and characteristics of sensors and transmitters.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10) and R.S. 17:10.

HISTORICAL NOTE: Promulgated by the Department of Education, Board of Elementary and Secondary Education, Trade and Industrial Education, LR 31:

§1725. Generators and Power Supplies

- A. Principles of Electromotive Force

- B. Principles of Generating Electricity:
 - 1. the parts, functions, operation, and characteristics of the AC generator;
 - 2. the parts, functions, operation, and characteristics of the DC generator;
 - 3. the “left hand rule” for generators;
 - 4. RPM, frequency and number of poles in a given generator;
 - 5. three-phase generation;
 - 6. wye and delta windings;
 - 7. three-phase sine wave.
- C. Types and Configurations of Uninterruptible Power Supplies (Ups)
- D. Types and Configurations of Battery Systems Used for Ups Systems

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10) and R.S.

17:10.

HISTORICAL NOTE: Promulgated by the Department of Education, Board of Elementary and Secondary Education, Trade and Industrial Education, LR 31:

§1727. Transformers

- A. Function, Operation, and Characteristics of Transformers:
 - 1. electrical principles involved in transformer operation;
 - 2. transformer classifications and applications;
 - 3. transformer losses;
 - 4. ratios for voltage and amperage with respect to turns.
- B. Selection and Installation of Transformers:
 - 1. nameplate information;
 - 2. techniques for sizing transformers (one and three phase);
 - 3. determining if given transformer meets voltage, current, and impedance requirements;
 - 4. calculating voltages and currents for load and windings;
 - 5. determining whether to use wye or delta wiring schemes;
 - 6. steps for receiving and preparing transformer for installation;
 - 7. necessary tests to assure proper operation;
 - 8. proper techniques for connecting power and load conductors;
 - 9. methods for determining proper types and values of electrical protective devices;
 - 10. proper grounding procedures.
- C. Distribution Systems:
 - 1. functions, operations, and characteristics of various types of distribution systems;
 - 2. criteria for selecting particular type of distribution system.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10) and R.S.

17:10.

HISTORICAL NOTE: Promulgated by the Department of Education, Board of Elementary and Secondary Education, Trade and Industrial Education, LR 31:

§1729. Personal Development

- A. Orientation
 - 1. Make up and organization of the industry:
 - a. jobsite chain of command;
 - i. owner/customer;

- ii. architects/engineers;
 - iii. inspection authorities;
 - iv. construction managers;
 - v. general contractors;
 - vi. other contractors.
 - 2. Organizations within industry:
 - a. manufacturers;
 - b. distributors;
 - c. associations;
 - d. unions.
- B. Methods of working with others:
 - 1. the three basic theories of motivation;
 - 2. need levels of humans;
 - 3. the role of supervisors:
 - a. leadership styles appropriate to certain situations;
 - b. need for competent supervisors;
 - 4. effective communications:
 - a. importance of communications in the industry and on the job;
 - b. barriers to communications;
 - c. keys to effective communications.
- C. Economic considerations:
 - 1. why worker's future is tied to employer's;
 - 2. responsibilities to employer:
 - a. keeping skills current;
 - b. managing your future;
 - 3. costs of doing business;
 - 4. importance of satisfying customers;
 - 5. impact of job performance, behavior and appearance on prospects for future work;
 - 6. functions of marketing.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10) and R.S. 17:10.

HISTORICAL NOTE: Promulgated by the Department of Education, Board of Elementary and Secondary Education, Trade and Industrial Education, LR 31:

§1731. Jobsite Management

- A. Coordinating Tool Needs with Offices of Other Jobs
- B. Coordinating Schedule with Other Crafts
- C. Developing Timetables and Progress Charts
- D. Completing Time Sheets, Logs and Other Necessary Documentation
- E. Clearances or Permits if Necessary
- F. Inventory and Order Necessary Equipment According to Job Needs
- G. Developing Alternative Solutions and Choosing the Best Alternative
- H. Planning and Organizing Tasks to Meet Deadlines
- I. Supervising and Monitoring Others
- J. Picturing the Way the Project Will Appear When Completed

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10) and R.S. 17:10.

HISTORICAL NOTE: Promulgated by the Department of Education, Board of Elementary and Secondary Education, Trade and Industrial Education, LR 31:

§1733. Testing

A. Steps Used for Various Testing Processes:

1. acceptance testing of cables;
2. maintenance testing of generators;
3. insulation tests using megohmmeter.

B. Utilizing the Results of Testing Procedures:

1. special requirements for high voltage testing;
2. describe potential safety hazards;
3. characteristics and properties of high voltage cable and insulators;
4. appropriate tests methods, voltages and equipment.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10) and R.S. 17:10.

HISTORICAL NOTE: Promulgated by the Department of Education, Board of Elementary and Secondary Education, Trade and Industrial Education, LR 31:

§1735. Specialty Systems

A. Fire Alarms:

1. functions, operations, and characteristics of various types of fire alarm systems and components;
2. Code requirements and use of Code to answer specific questions;
3. functions, operations, and characteristics of alarm initiating and indicating devices;
4. multiplexing of system components;
5. various types of areas and methods to protect them;
6. appropriate wiring methods and devices;
7. utilize manuals to start-up and check out systems;
8. utilize proper manuals and techniques for system maintenance and troubleshooting.

B. Security Alarms:

1. functions, operations, and characteristics of various types of security systems and components;
2. Code requirements and use of Code to answer specific questions;
3. functions, operations, and characteristics of alarm initiating and indicating devices;
4. multiplexing of system components;
5. various types of areas and methods to protect them;
6. appropriate wiring methods and devices;
7. utilize manuals to start-up and check out systems;
8. utilize proper manuals and techniques for system maintenance and troubleshooting.

C. Voice, Data, TV, Signaling Systems:

1. functions, operations, and characteristics of various types of voice, data, TV, and signaling systems;

2. proper cabling systems required for various systems (telephone, data, Local Area Networks, etc.);
3. installation and connection techniques for cables and devices;
4. how cable defects and installation errors can degrade data transfer;
5. utilize manuals to install, test and start-up and check out systems;
6. utilize proper manuals and techniques for system maintenance and troubleshooting.

D. Lightning Protection Systems:

1. functions, operations, and characteristics of lightning protection systems;
2. the sizing, layout and installation of lightning protection systems;
3. NEC requirements and interpretations;
4. size of conductors and electrodes;
5. installation of electrodes;
6. installation of conductors and connections to electrodes.

E. Fiber Optic Systems:

1. functions, operations, and characteristics of fiber optic cable;
2. proper installation techniques:
 - a. minimum bend radius;
 - b. pulling techniques;
 - c. installation hardware;
 - d. splicing and termination;
3. utilize appropriate manuals and equipment to perform system tests and troubleshooting.

F. Heating, Air Conditioning and Refrigeration:

1. functions, operations, and characteristics of heating, air conditioning and refrigeration systems and components;
2. the characteristics of heat energy, transfer, and measurement;
3. space and process heating;
4. the properties and characteristics of refrigerants;
5. the appropriate piping techniques for refrigerants;
6. utilize appropriate manuals and equipment to perform system tests and troubleshooting.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10) and R.S. 17:10.

HISTORICAL NOTE: Promulgated by the Department of Education, Board of Elementary and Secondary Education, Trade and Industrial Education, LR 31:

Chapter 19. National Skill Standards

§1901. Competencies, Foundation Skills, and Academic Cross-References

A. Standard 1: Explain the importance of safety and demonstrate safe practices in all electrical work.

Benchmarks	Louisiana Foundation Skills	National Skill Standard	Academic Cross-Reference (Standard-Benchmark)
I. GENERAL JOBSITE SAFETY AWARENESS		I-A	English Language Arts (ELA)
A. Explain the importance of safety and the key factors involved in safe work practice.	1, 3, 4, 5	I-A1, IA2	ELA 1-H1, H3, H4, H5 ELA 2-H2, H3
B. Explain the dangers of electrical shock, describe potential shock hazard situations, use no contact voltage indicators and other devices to determine if the system is energized and demonstrate proper techniques for working on energized circuits.	1, 2, 3, 4	I-A3	ELA 3-H2, H3 ELA 4-H1, H2, H3, H4, H5, H6 ELA 5-H1, H2, H3, H6 ELA 7-H1, H2
C. Identify and correct hazards created by poor housekeeping.	1, 5	I-A4	Mathematics N-1H, 2H, 3H, 4H, 5H, 6H, 7H A-1H, 2H, 3H, 4H M-1H, 2H, 3H, 4H D-7H, 9H G-1H, 2H, 3H, 4H, 5H, 6H Social Studies G-1D-H1, 1D-H2, 1D-H4 C-1A-H1, 1A-H5 E-1A-H1, 1A-H2, 1A-H3, 1A-H6 1B-H1, 1B-H2, 1B-H4, 1B-H5, 1B-H6 Science PS-H-B1, E1, F1, F2, G1, G2, G3, G4, G5 ESS-H-A1 SE-H-A11, B1, B6, C2, C4, C5, D1, D2, D3, D4, D5, D6
D. Maintain a safe work area and tools.	1, 4	I-A5	
E. Explain the dangers of falling objects.	1, 4	I-A6	
F. Demonstrate respect and observance job safety rules.	1, 4, 5	I-A7	
	1, 4, 5	I-B	
	1, 4, 5	I-B1	
II. EMERGENCY PROCEDURES			
A. Demonstrate competency in first aid training, particularly in the area of electrical shock.	1, 5	I-B2	
B. Demonstrate proper CPR procedures.	1, 4	I-B-3	
C. Explain the means to effect emergency rescues.	1, 4	I-C	
	1, 2, 5	I-C1	
	1, 4	I-C2	
III. COMPLIANCE WITH OSHA AND EPA REGULATIONS	1, 2, 4	I-C3	
A. Participate in/conduct a regular safety meeting.	1, 2, 4	I-C4	Science PS-H-B1, E1, F1, F2, G1, G2, G3, G4, G5 ESS-H-A1 SE-H-A11, B1, B6, C2, C4, C5, D1, D2, D3, D4, D5, D6
B. Explain the general OSHA jobsite requirements.	1, 4	I-D	
C. Explain and apply the guidelines for OSHA Assured Equipment Grounding and CFCI usage.	1, 4	I-D1	
	1, 4	I-D2	
D. Use material safety data sheets (MSDS) to identify and properly handle hazardous.	1, 3, 4	I-D3	
IV. SUBSTANCE ABUSE			
A. Identify common drugs and explain their effects.			
B. Identify the indicators of and explain how to handle substance abuse.			
C. Identify substance abuse sources of information and assistance.			

B. Standard 2: Select and use appropriate tools and materials on the job.

Benchmarks	Louisiana Foundation Skills	National Skill Standard	Academic Cross-Reference (Standard-Benchmark)
I. GENERAL JOBSITE SAFETY AWARENESS		II-A	English Language Arts (ELA)
A. Select, use, and care for common hand and power tools.	1, 2 1, 2	II-A1-4 II-A5	ELA 1-H1, H3, H4, H5 ELA 2-H2, H3
B. Demonstrate ladder safety.	1, 2, 3, 4	II-A6	ELA 3-H2, H3
C. Explain tool defects.	1, 2	II-A7	ELA 4-H1, H2, H3, H4, H5, H6
D. Use various meters to read variables.		II-B	ELA 5-H1, H2, H3, H6 ELA 7-H1, H2
II. PROPER RIGGING METHODS	1, 2, 3	II-B1 II-B2 II-B3	Mathematics N-1H, 2H, 3H, 4H, 5H, 6H, 7H A-1H, 2H, 3H, 4H M-1H, 2H, 3H, 4H D-7H, 9H G-1H, 2H, 3H, 4H, 5H, 6H
A. Explain the use of knots in electrical work and demonstrate knot making.	1, 2, 3	II-C	
B. Apply proper techniques for rigging and hoisting.	1, 2, 3	II-C1	
C. Explain the safe capacities for various lifting arrangements.	1, 2, 3	II-C2	
III. PROPER DIGGING TECHNIQUES	1, 2, 3	II-D	Social Studies G-1D-H1, 1D-H2, 1D-H4 C-1A-H1, 1A-H5 E-1A-H1, 1A-H2, 1A-H3, 1A-H6 1B-H1, 1B-H2, 1B-H4, 1B-H5, 1B-H6
A. Explain the determination of depth and shape of holes for supporting poles.	1, 2, 3	II-E	
B. Explain the proper techniques for digging, grading and leveling trenches for ductwork.	1, 2, 3 1, 2, 3	II-E1 II-E2	
IV. EXPLAIN THE USE OF MOTORIZED TOOLS IN ELECTRICAL WORK			Science
V. PROPER MATERIAL MANAGEMENT			PS-H-B1, E1, F1, F2, G1, G2, G3, G4, G5 ESS-H-A1 SE-H-A11, B1, B6, C2, C4, C5, D1, D2, D3, D4, D5, D6
A. Identify the materials commonly used in electrical work.			
B. Explain materials sections in terms of application.			

C. Standard 3: Perform mathematical computation common to the electrical trade.

Benchmarks	Louisiana Foundation Skills	National Skill Standard	Academic Cross-Reference (Standard-Benchmark)
I. APPLY ARITHMETIC OPERATIONS TO SOLVE ELECTRICAL PROBLEMS.	1, 2, 3	III-1-5, 9	English Language Arts (ELA) ELA 1-H1, H3, H4, H5 ELA 2-H2, H3, H6 ELA 3-H1, H3
II. SOLVE PROBLEMS AND DETERMINE THE ANGLES AND SIDES OF TRIANGLES.	1, 2, 3	III-6-7	ELA 4-H2, H3, H4, H5, H6 ELA 5-H1, H2, H3, H4, H5, H6 ELA 7-H1, H2
III. PERFORM METRIC CALCULATIONS AND CONVERT METRIC TO THE ENGLISH SYSTEM AND VICE VERSA.	1, 2, 3	III-11	
	1, 2, 3	III-12-13	Mathematics N-1H, 2H, 3H, 4H, 5H, 7H A-1H, 2H, 3H, 4H M-1H, 2H, 3H, 4H D-2H, 4H, 7H, 8H, 9H G-1H, 2H, 3H, 5H, 6H
IV. PERFORM CALCULATIONS USING ALGEBRA TO SOLVE ELECTRICAL PROBLEMS.	1, 2, 3	III-14	
V. USE SQUARE ROOT, RATIO, PERCENT, AND PROPORTION			Social Studies

Benchmarks	Louisiana Foundation Skills	National Skill Standard	Academic Cross-Reference (Standard-Benchmark)
VI. TO SOLVE PROBLEMS. SOLVE PROBLEMS INVOLVING DIRECT AND INVERSE RELATIONSHIPS.			G-1C-H2, 1D-H1, 1D-H2, 1D, H4 E-1A-H1, 1A-H2, 1A-H3, 1A-H6 1B-H1, 1B-H2, 1B-H4, 1B-H4, 1B-H6 Science PS-H-B1, PS-H-E1, PS-H-F1, PS-H-F2, PS-H-G2, PS-H-G3, PS-H-G4, SE-H-D2, SE-H-D6

D. Standard 4: Apply electrical theory in designing, construction, and trouble-diagnosing electrical circuits.

Benchmarks	Louisiana Foundation Skills	National Skill Standard	Academic Cross-Reference (Standard-Benchmark)
I. BASIC ELECTRICAL THEORY A. Define the terms associated with electrical theory. B. Explain the generation of electricity. C. Explain the utilization of electricity.	1, 2, 3 1, 2, 3 1, 2, 3 1, 2, 3 1, 2, 3	IV-A IV-A-1 IV-A-2, 3 IV-A-4 IV-B IV-B-1 IV-B-2	English Language Arts (ELA) ELA 1-H1, H3, H4, H5 ELA 2-H2, H3 ELA 3-H2, H3 ELA 4-H1, H2, H3, H4, H5, H6 ELA 5-H1, H2, H3, H6 ELA 7-H1, H2
II. OHM'S LAW, KIRCHOFF'S LAW, LENZ'S LAW, THEVENIN'S AND NORTON'S THEOREMS A. Explain the use of laws and theorems in electrical work. B. Solve problems involving the electrical laws and theories.	1, 2, 3 1, 2, 3 1, 2, 3 1, 2, 3 1, 2, 3 1, 2, 3	IV-C IV-C-1 IV-C-2, 3 IV-C-4 IV-C-5 IV-C-6 IV-D IV-D-1, 4	Mathematics N-1H, 2H, 3H, 4H, 5H, 6H, 7H A-1H, 2H, 3H, 4H M-1H, 2H, 3H, 4H D-7H, 9H G-1H, 2H, 3H, 4H, 5H, 6H
III. SERIES CIRCUITS A. Explain the operation and construction of series circuits. B. Calculate resistance and total resistance in series circuits. C. Explain the effects of charging voltage and resistance. D. Explain the law of proportion series voltage divider circuits. E. Calculate power in series circuits.	1, 2, 3 1, 2, 3 1, 2, 3 1, 2, 3 1, 2, 3 1, 2, 3	IV-D-2 IV-D-3 IV-D-5 IV-D-6, 7 IV-D-8 IV-D-9 IV-E IV-E-1, 2 IV-E-3 IV-E-4 IV-E-5 IV-E-6	Social Studies G-1D-H1, 1D-H2, 1D-H4 C-1A-H1, 1A-H5 E-1A-H1, 1A-H2, 1A-H3, 1A-H6 1B-H1, 1B-H2, 1B-H4, 1B-H5, 1B-H6
IV. PARALLEL CIRCUITS A. Explain the construction and operation of parallel circuits. B. Explain the differences between series and parallel circuits. C. Calculate Ohm's Law for parallel	1, 2, 3	IV-F IV-F-1 IV-F-2, 3	Science PS-H-B1, E1, F1, F2, G1, G2, G3, G4, G5 ESS-H-A1 SE-H-A11, B1, B6, C2, C4, C5, D1, D2, D3, D4, D5, D6

Benchmarks	Louisiana Foundation Skills	National Skill Standard	Academic Cross-Reference (Standard-Benchmark)
circuits. D. Calculate total resistance in parallel circuits. E. Explain current/alternative current paths. F. Explain the law of proportion. G. Calculate power requirements of components. V. COMBINATION CIRCUITS A. Explain the operation and construction of combination circuits. B. Calculate equivalent resistance. C. Explain alternate current paths. D. Calculate Ohm's Law. E. Explain power use and dissipation. VI. CHARACTERISTICS OF VOLTAGES IN CIRCUITS A. Explain polarity and the flow of electrons. B. Explain distribution, calculate voltage drop, and determine wire size to reduce losses.			
VII. EXPLAIN THE CHARACTERISTICS OF MAGNETISM/ELECTROMAGNETISM. VIII. EXPLAIN THE THEORY OF SUPERPOSITION AND SOLVING MULTIPLE VOLTAGE SOURCE CIRCUITS. IX. EXPLAIN THE OPERATION AND CHARACTERISTICS OF THREE WIRE SYSTEMS. X. EXPLAIN THE OPERATION AND CHARACTERISTICS OF THREE PHASE SYSTEMS. A. Explain the differences between and construct three wire and three phase circuits. B. Calculate voltage drop and power loss. XI. AC THEORY A. Define terms associated with AC theory. B. Calculate currents and voltages for components and circuits.	1, 2, 3 1, 2, 3 1, 2, 3 1, 2, 3 1, 4 1, 4 2, 3 2, 3 2, 3 2, 3 2, 4 3 3, 4 2, 4	IV-G IV-H IV-I IV-J IV-J-1 IV-J-2 IV-K IV-K-1 IV-K-2 IV-K-3 IV-K-4 IV-K-5 IV-K-6 IV-K-6a IV-K-6b IV-K-6c	

Benchmarks	Louisiana Foundation Skills	National Skill Standard	Academic Cross-Reference (Standard-Benchmark)
C. Determine conductor size using the NEC. D. Generate current voltage sine waves to demonstrate phase relationships. E. Define <i>maximum</i> , <i>effective (rms)</i> , <i>average</i> , and <i>peak-to-peak</i> voltage and current. F. Define <i>inductance</i> . <ol style="list-style-type: none"> 1. Explain factors that affect inductance. 2. Explain the behavior of current when inductance is present. 3. Explain the relationship between current, applied voltage, and counter electromotive force. 4. Calculate inductive reactance when frequency and inductance are known. 5. Calculate inductance, inductive reactance, and unknowns in various circuits. 	2, 3, 4 2, 3, 4	IV-K-6d IV-K-6e	
G. Define <i>capacitance</i> . <ol style="list-style-type: none"> 1. Explain the effects on circuits of capacitance. 2. Explain the relationships between capacitance, capacitive reactance, and frequency. H. Explain the relationships and behaviors of series RL, parallel RL, series RC, parallel RC, series LC, parallel LC, series LCR and parallel LCR circuits. I. Explain the function, operation, and characteristics of rectifiers. <ol style="list-style-type: none"> 1. Explain the actions of full wave and half rectifiers. 2. Interpret schematics. J. Explain the series resonance, parallel resonance and circuits. K. Explain the use of filters in electrical circuits. L. Define <i>power factor</i> .	2, 3, 4 2, 3, 4 2, 3, 4 2, 3, 4 2, 3, 4 2, 4 2, 4 2, 4 2, 4 2, 3, 4 2, 3, 4 2, 4 2, 3, 4 2, 4 2, 3, 4 2, 4 2, 3, 4 2, 4 2, 3, 4	IV-K-7 IV-K-7a IV-K-7b IV-K-8 IV-K-9 IV-K-9a IV-K-9b IV-K-10 IV-K-11 IV-K-12 IV-K-12a IV-K-12b IV-K-12c IV-K-12d V-K-13 IV-K-13a IV-K-13b IV-K-13c IV-K-13d	

Benchmarks	Louisiana Foundation Skills	National Skill Standard	Academic Cross-Reference (Standard-Benchmark)
<ol style="list-style-type: none"> 1. Calculate watts, bars and volt-amperes. 2. Explain reactive power. 3. Explain the proper placement of power factor correction capacitors. 4. Explain the procedure to recognize and correct poor power factor arrangements. <p>M. Define <i>power quality</i>.</p> <ol style="list-style-type: none"> 1. Explain causes of poor power quality. 2. Explain the effects of harmonics. 3. Explain the procedure of locating harmonics through observation and test equipment. 4. Explain techniques to reduce or eliminate effects of harmonics. 			
XII. USE OF ELECTRONICS <ol style="list-style-type: none"> A. Explain electron flow through solid-state components. B. Explain precautions to be taken against electrostatic discharges around semiconductor devices. C. Explain the functions, operations, characteristics, and testing of diodes. D. Explain the functions, operations, and characteristics of transducers. E. Explain the functions, operations, characteristics, and testing of various types of transistors (diacs, triacs, SCRs, etc.). F. Explain the functions, operations, characteristics, and circuit configurations of amplifiers. G. Explain the functions, operations, and characteristics of integrated circuits (ICs). H. Explain the functions, operations, and characteristics of the three main categories of photo-operated devices. 	<ol style="list-style-type: none"> 2, 4 2, 4 2, 4 2, 4 2, 4 2, 4 2, 4 2, 4 	<p>V-L</p> <ol style="list-style-type: none"> IV-L-1 IV-L-2 IV-L-3 IV-L-4 IV-L-5 IV-L-6 IV-L-7 IV-L-8 IV-L-9 	

Benchmarks	Louisiana Foundation Skills	National Skill Standard	Academic Cross-Reference (Standard-Benchmark)
I.. Explain the construction and operation of digital and logic circuits.			

E. Standard 5: Explain and apply code requirements.

Benchmarks	Louisiana Foundation Skills	National Skill Standard	Academic Cross-Reference (Standard-Benchmark)
I. EXPLAIN THE PURPOSE AND INTENT OF ELECTRICAL CODES.	1, 2, 3, 4, 5 1, 2, 3, 4, 5	V-1 V-2	English Language Arts (ELA) ELA 1-H1, H3, H4, H5 ELA 2-H2, H3 ELA 3-H2, H3
II. EXPLAIN THE SCOPE OF THE NATIONAL ELECTRIC CODE (NEC) AND LOCAL CODES.	1, 2, 3, 4, 5 1, 2, 3, 4, 5	V-3 V-4	ELA 4-H1, H2, H3, H4, H5, H6 ELA 5-H1, H2, H3, H6 ELA 7-H1, H2
III. EXPLAIN AND PROVIDE EXAMPLES OF HOW LOCAL CODES MAY DIFFER FROM THE NEC.	1, 2, 3, 4, 5 1, 2, 3, 4, 5	V-5 V-6	Mathematics N-1H, 2H, 3H, 4H, 5H, 6H, 7H A-1H, 2H, 3H, 4H M-1H, 2H, 3H, 4H D-7H, 9H G-1H, 2H, 3H, 4H, 5H, 6H
IV. EXPLAIN THE ORGANIZATION AND STRUCTURE OF THE NEC.			Social Studies G-1D-H1, 1D-H2, 1D-H4 C-1A-H1, 1A-H5 E-1A-H1, 1A-H2, 1A-H3, 1A-H6 1B-H1, 1B-H2, 1B-H4, 1B-H5, 1B-H6
V. USE THE NEC TO CALCULATE VARIOUS GENERAL JOB REQUIREMENTS.			Science PS-H-B1, E1, F1, F2, G1, G2, G3, G4, G5 ESS-H-A1 SE-H-A11, B1, B6, C2, C4, C5, D1, D2, D3, D4, D5, D6
VI. APPLY NEC REQUIREMENTS FOR HAZARDOUS LOCATIONS.			

F. Standard 6: Select and Install Conductors

Benchmarks	Louisiana Foundation Skills	National Skill Standard	Academic Cross-Reference (Standard-Benchmark)
I. TYPES OF CONDUCTORS		VI-A	English Language Arts (ELA)
A. Explain the use of the various types of conductors and insulators.	1, 2, 3 1, 2, 3	VI-A-1 VI-A-2, 5	ELA 1-H1, H3, H4, H5 ELA 2-H2, H3 ELA 3-H2, H3
B. Identify the common conductors			

Benchmarks	Louisiana Foundation Skills	National Skill Standard	Academic Cross-Reference (Standard-Benchmark)
materials and explain their advantages and disadvantages. C. Explain the effects of heat on insulators. D. Determine the appropriate type and size of conductors for various jobs. E. Explain the properties of high voltage cable. F. Explain the effects of varying soil conditions on underground cable.	1, 2, 3 1, 2, 3 1, 2, 3 1, 2, 3 1, 2, 3	VI-A-3 VI-A-4 VI-A-6 VI-A-7 VI-B VI-B-1	ELA 4-H1, H2, H3, H4, H5, H6 ELA 5-H1, H2, H3, H6 ELA 7-H1, H2
II. CONDUCTOR INSTALLATION TECHNIQUES A. Explain various wiring methods for particular types of conductors and situations. B. Demonstrate different methods of installing conductors in conduits, raceways and cable trays. C. Demonstrate proper splicing methods and techniques for various conductors and locations.	1, 2, 3 1, 2, 3 1, 2, 3 1, 2, 3 1, 2, 3	VI-B-2 VI-B-3 VI-C VI-C-1 VI-C-2 VI-C-3 VI-C-4 VI-C-5	Mathematics N-1H, 2H, 3H, 4H, 5H, 6H, 7H A-1H, 2H, 3H, 4H M-1H, 2H, 3H, 4H D-7H, 9H G-1H, 2H, 3H, 4H, 5H, 6H Social Studies G-1D-H1, 1D-H2, 1D-H4 C-1A-H1, 1A-H5 E-1A-H1, 1A-H2, 1A-H3, 1A-H6 1B-H1, 1B-H2, 1B-H4, 1B-H5, 1B-H6 Science PS-H-B1, E1, F1, F2, G1, G2, G3, G4, G5 ESS-H-A1 SE-H-A11, B1, B6, C2, C4, C5, D1, D2, D3, D4, D5, D6
III. METHODS FOR SELECTING CONDUCTORS A. Use code requirements to determine the appropriate conductor selection for various jobs. B. Perform mathematical calculation to determine current capacity of conductors. C. Calculate or select cable ampacity from NEC tables. D. Determine loads for sizing conductors. E. Interpret code requirements for various types of circuits and loads (lighting, appliance, heating, service entrance).	1, 2, 3 1, 2, 3 1, 2, 3 1, 2, 3 1, 2, 3	VI-D VI-D-1 VI-D-2	
IV. CABLE FAULT SITUATIONS A. Explain the various types of cable faults and their cause. B. Explain the various methods and equipment used to determine cable faults.			

G. Standard 7: Install Conduit, Raceways, Panelboards and Switchboards

Benchmarks	Louisiana Foundation Skills	National Skill Standard	Academic Cross-Reference (Standard-Benchmark)
I. DEFINE THE TERMS ASSOCIATED WITH CONDUITS AND RACEWAYS II. CONDUCT AND WIRING	1, 2, 3, 4 1, 2, 3	VII-A VII-B VII-B-1	English Language Arts (ELA) ELA 1-H1, H3, H4, H5 ELA 2-H2, H3 ELA 3-H2, H3

Benchmarks	Louisiana Foundation Skills	National Skill Standard	Academic Cross-Reference (Standard-Benchmark)
SUPPORT SYSTEMS RECOGNIZED BY CODE	1, 2, 3	VII-B-2	ELA 4-H1, H2, H3, H4, H5, H6
A. Select appropriate types of conduct.	1, 2, 3	VII-B-3	ELA 5-H1, H2, H3, H6
B. Select and install appropriate connectors.	1, 2, 3	VII-B-4	ELA 7-H1, H2
C. Select and install appropriate fastening devices and reinforcements.	1, 2, 3	VII-D	
D. Accommodate special consideration in using conduct.	1, 2, 3	VII-D-1	Mathematics N-1H, 2H, 3H, 4H, 5H, 6H, 7H
	1, 2, 3	VII-D-2	A-1H, 2H, 3H, 4H
	1, 2, 3	VII-D-3	M-1H, 2H, 3H, 4H
	1, 2, 3	VII-D-4	D-7H, 9H
	1, 2, 3	VII-D-5	G-1H, 2H, 3H, 4H, 5H, 6H
	1, 2, 3	VII-D-6	
III. PROCEDURES FOR LAYING OUT VARIOUS TYPES OF BENDS	1, 2, 3	VII-D-7	Social Studies G-1D-H1, 1D-H2, 1D-H4
A. Explain take-up and gain.	1, 2, 3	VII-D-8	C-1A-H1, 1A-H5
B. Form kicks and offsets.	1, 2, 3	VII-D-9	E-1A-H1, 1A-H2, 1A-H3, 1A-H6
C. Calculate degrees.	1, 2, 3	VII-D	1B-H1, 1B-H2, 1B-H4, 1B-H5, 1B-H6
D. Form back-to-back bends.	1, 2, 3	VII-D-1	
E. Calculate conduct length.	1, 2, 3, 4	VII-D-2	
F. Locate bend points.	1, 2, 3	VII-E	Science PS-H-B1, E1, F1, F2, G1, G2, G3, G4, G5
G. Demonstrate four techniques for segment bending.		VII-F	ESS-H-A1
H. Demonstrate forming concentric bends.	1, 2, 3		SE-H-A11, B1, B6, C2, C4, C5, D1, D2, D3, D4, D5, D6
I. Calculate the radius of circles.	1, 2, 3	VII-G	
IV. PROCEDURES FOR MAKING BENDS WHEN FABRICATING CONDUITS	1, 2, 3	VII-G-1	
A. Use hand benders to make bends on small diameter conduit.	1, 2, 3	VII-G-2	
B. Use power benders to make bends on large diameter pipe.	1, 2, 3	VII-G-3	
V. FABRICATE RACEWAYS AND WIRING SUPPORT SYSTEMS	1, 2, 3	VII-G-4	
VI. PERFORM CABLE ASSEMBLY WIRING METHODS RECOGNIZED BY CODE			
VII. FUNCTIONS, OPERATIONS AND REQUIREMENTS FOR VARIOUS PANELBOARDS AND SWITCHGEAR			
A. Install panels.			
B. Install components within panels.			
C. Attach wiring and connectors.			
D. Explain special considerations and occupancies.			

H. Standard 8: Installing Lighting Systems

Benchmarks	Louisiana Foundation Skills	National Skill Standard	Academic Cross-Reference (Standard-Benchmark)
I. EXPLAIN THE FUNCTIONS, OPERATION, AND CHARACTERISTICS OF VARIOUS LIGHTING SYSTEMS A. Install incandescent lighting systems. B. Install florescent lighting systems. C. Install HID lighting systems. D. Install low voltage lighting systems.	1, 2, 3 1, 2, 3 1, 2, 3 1, 2, 3	VIII-A VIII-A1-B, C VIII-A2-B, C VIII-A3-B, C VIII-A4-B, C	English Language Arts (ELA) ELA 1-H1, H3, H4, H5 ELA 2-H2, H3 ELA 3-H2, H3 ELA 4-H1, H2, H3, H4, H5, H6 ELA 5-H1, H2, H3, H6 ELA 7-H1, H2 Mathematics N-1H, 2H, 3H, 4H, 5H, 6H, 7H A-1H, 2H, 3H, 4H M-1H, 2H, 3H, 4H D-7H, 9H G-1H, 2H, 3H, 4H, 5H, 6H Social Studies G-1D-H1, 1D-H2, 1D-H4 C-1A-H1, 1A-H5 E-1A-H1, 1A-H2, 1A-H3, 1A-H6 1B-H1, 1B-H2, 1B-H4, 1B-H5, 1B-H6 Science PS-H-B1, E1, F1, F2, G1, G2, G3, G4, G5 ESS-H-A1 SE-H-A11, B1, B6, C2, C4, C5, D1, D2, D3, D4, D5, D6

I. Standard 9: Explain the Use of Overcurrent Protection Devices and Reform Appropriate Calculations

Benchmarks	Louisiana Foundation Skills	National Skill Standard	Academic Cross-Reference (Standard-Benchmark)
I. FUNCTIONS, OPERATION, AND CHARACTERISTICS OF OVERCURRENT DEVICES A. Explain the purpose of over-current devices and their proper placement. B. Name three considerations necessary for electrical component protection. C. Explain interrupting ratings. D. Explain short circuit currents. E. Explain overload and over current situations that might arise. F. Explain the 10 and 25-foot tap rules. G. Explain the operation and	1, 3, 4 1, 2, 3, 4 1, 3, 4 1, 2, 3, 4 1, 3, 4 1, 3, 4 1, 3, 4 1, 3, 4 1, 2, 3, 4	IX-1 IX-2 IX-3 IX-4 IX-5 IX-6 IX-7 IX-8 IX-9	English Language Arts (ELA) ELA 1-H1, H3, H4, H5 ELA 2-H1, H3, H6 ELA 3-H1, H3 ELA 4-H2, H3, H4, H5, H6 ELA 5-H1, H2, H3, H4, H5, H6 ELA 7-H1, H2 Mathematics N-1H, 2H, 3H, 4H, 5H, 7H A-1H, 2H, 3H, 4H M-1H, 2H, 3H, 4H D-2H, 4H, 7H, 8H, 9H G-1H, 2H, 3H, 5H, 6H Social Studies

Benchmarks	Louisiana Foundation Skills	National Skill Standard	Academic Cross-Reference (Standard-Benchmark)
<p>application of single element and time delay fuses, and the effects of heat.</p> <p>H. Explain the operation and application of the various types of circuit breakers.</p> <p>I. Explain the peak-let-thru charts and table to determine specifications.</p> <p>J. Explain the function, operation, and characteristics of ground fault circuit interrupters.</p> <p>K. Explain the function, operations, and characteristics of surge protectors.</p> <p>L. Select appropriate devices for various situations according to code.</p>	<p>1, 3, 4</p> <p>1, 3, 4</p> <p>1, 3, 4</p>	<p>IX-10</p> <p>IX-11</p> <p>IX-12</p>	<p>G-1-C-H2, 1D-H1, 1D-H2, 1D-H4, E-1A-H1, 1A-H2, 1A-H3, 1A-H6, 1B-H1, 1B-H2, 1B-H4, 1B-H6</p> <p>Science</p> <p>PS-H-B1, PS-H-E1, PS-H-F1, PS-H-F2, PS-H-G2, PS-H-G3, PS-H-G4, SE-H-D2, SE-H-D6</p>

J. Standard 10: Installing Grounding Systems.

Benchmarks	Louisiana Foundation Skills	National Skill Standard	Academic Cross-Reference (Standard-Benchmark)
<p>I. FUNCTIONS, OPERATION, AND CHARACTERISTICS OF GROUNDING SYSTEMS</p> <p>A. Explain the necessity of grounding systems.</p> <p>B. Name and explain the general types of faults.</p> <p>C. Explain the operations and characteristics of grounding electrode systems.</p>	<p>1, 2, 3, 4</p> <p>1, 2, 3</p> <p>1, 2, 3</p>	<p>X-A</p> <p>X-A-1</p> <p>X-A-2</p> <p>X-A-3</p>	<p>English Language Arts (ELA)</p> <p>ELA 1-H1, H3, H4, H5</p> <p>ELA 2-H2, H3</p> <p>ELA 3-H2, H3</p> <p>ELA 4-H1, H2, H3, H4, H5, H6</p> <p>ELA 5-H1, H2, H3, H6</p> <p>ELA 7-H1, H2</p>
<p>II. SIZING, LAYOUT AND INSTALLATION OF GROUNDING SYSTEMS</p> <p>A. Explain the NEC requirements and interpretations for installing grounding systems.</p> <p>B. Determine the size of conductors and electrodes.</p> <p>C. Install electrodes.</p> <p>D. Install conductors and make connections to electrodes.</p> <p>E. Explain the impact of soil conditions on earth grounding systems and electrodes.</p> <p>F. Explain the principles and the procedure of earth resistance testing.</p> <p>G. Determine applications where ground fault protection is required.</p>	<p>1, 2, 3, 4</p> <p>1, 2, 3, 4</p> <p>1, 2, 3</p> <p>1, 2, 3</p> <p>1, 2, 3</p> <p>1, 2, 3</p> <p>1, 2, 3</p>	<p>X-B</p> <p>X-B-1</p> <p>X-B-2</p> <p>X-B-3</p> <p>X-B-4</p> <p>X-B-5</p> <p>X-B-6</p> <p>X-B-7</p> <p>X-C</p> <p>X-D</p> <p>X-E</p>	<p>Mathematics</p> <p>N-1H, 2H, 3H, 4H, 5H, 6H, 7H</p> <p>A-1H, 2H, 3H, 4H</p> <p>M-1H, 2H, 3H, 4H</p> <p>D-7H, 9H</p> <p>G-1H, 2H, 3H, 4H, 5H, 6H</p> <p>Social Studies</p> <p>G-1D-H1, 1D-H2, 1D-H4</p> <p>C-1A-H1, 1A-H5</p> <p>E-1A-H1, 1A-H2, 1A-H3, 1A-H6</p> <p>1B-H1, 1B-H2, 1B-H4, 1B-H5, 1B-H6</p>
<p>III. EXPLAIN THE DIFFERENCE BETWEEN INSULATION, ISOLATION, AND ELEVATION</p>	<p>1, 2, 3, 4</p> <p>1, 2, 3, 4</p> <p>1, 2, 3, 4</p>	<p>X-E-1</p> <p>X-E-2</p>	<p>Science</p> <p>PS-H-B1, E1, F1, F2, G1, G2,</p>

Benchmarks	Louisiana Foundation Skills	National Skill Standard	Academic Cross-Reference (Standard-Benchmark)
IV. EXPLAIN THE DIFFERENCE BETWEEN GROUNDING, GROUNDED, AND BONDING V. EXPLAIN SPECIAL CIRCUMSTANCES WITH GROUNDING SYSTEMS A. Explain requirements for grounding systems over 1,000-volt capacity. B. Explain grounding requirements for separately derived systems. C. Explain ground requirements for buildings that share service.	1, 2, 3, 4	X-E-3	G3, G4, G5 ESS-H-A1 SE-H-A11, B1, B6, C2, C4, C5, D1, D2, D3, D4, D5, D6

K. Standard 11: Reading and Interpreting Prints and Specifications

Benchmarks	Louisiana Foundation Skills	National Skill Standard	Academic Cross-Reference (Standard-Benchmark)
I. CREATION OF BLUEPRINTS, PLANS, AND SPECIFICATIONS A. Use electrical symbols. B. Distinguish between the basic types of lines and explain their use. C. Identify drawing instruments and types of drawings. D. Take-off dimensions and use them on the job. E. Prepare “as-built” drawings. F. Explain the differences between wiring diagrams, line drawings, schematics, and ladder diagrams.	1, 2, 3, 4 1, 2, 3 1, 2, 3 1, 2, 3 1, 2, 3 1, 2, 3	XI-A XI-A-1 XI-A-2 XI-A-3 XI-A-4 XI-A-5 XI-A-6	English Language Arts (ELA) ELA 1-H1, H3, H4, H5 ELA 2-H2, H3 ELA 3-H2, H3 ELA 4-H1, H2, H3, H4, H5, H6 ELA 5-H1, H2, H3, H6 ELA 7-H1, H2
II. USE BLUEPRINTS, PLANS AND SPECIFICATIONS A. Explain the function of various types of plots, sections, details, schedules, specification sheets, addendums and revisions. B. Determine devices, locations, quantities, feeds, conduit types and sizes and conductor sizes from prints. C. Interpret non-electrical dimensions and considerations from prints. D. Explain the relationships between architectural considerations and electrical installation. E. Correlate information from other trades plans with electrical plans to determine potential conflicts.	1, 2, 3, 4 1, 2, 3, 4 1, 2, 3 1, 2, 3 1, 2, 3, 4	XI-B XI-B-1 XI-B-2 XI-B-3 XI-B-4 XI-B-5	Mathematics N-1H, 2H, 3H, 4H, 5H, 6H, 7H A-1H, 2H, 3H, 4H M-1H, 2H, 3H, 4H D-7H, 9H G-1H, 2H, 3H, 4H, 5H, 6H Social Studies G-1D-H1, 1D-H2, 1D-H4 C-1A-H1, 1A-H5 E-1A-H1, 1A-H2, 1A-H3, 1A-H6 1B-H1, 1B-H2, 1B-H4, 1B-H5, 1B-H6 Science PS-H-B1, E1, F1, F2, G1, G2, G3, G4, G5 ESS-H-A1 SE-H-A11, B1, B6, C2, C4, C5, D1, D2, D3, D4, D5, D6

L. Standard 12: Explain the Function, Operation and Characteristics of the Various Motors, Motor Controllers and Process Controllers

Benchmarks	Louisiana Foundation Skills	National Skill Standard	Academic Cross-Reference (Standard-Benchmark)
I. FUNCTIONS, OPERATIONS, AND CHARACTERISTICS OF VARIOUS TYPES OF MOTORS		XII-A	English Language Arts
A. Explain the construction and operation of various motors.	1, 3, 4	XII-A-1	ELA-1-H1, H3, H4, H5
B. Use information sheets, plans, schematics and motor nameplates to gather information.	1, 3, 4	XII-A-2	ELA-2-H1, H3, H6
C. Explain motor losses.	1, 2, 3, 4	XII-A-3	ELA-3-H1, H3
D. Describe starting and operating characteristics of motors.	1, 2, 3, 4	XII-A-4	ELA-4-H2, H3, H4, H5, H6
E. Explain methods to identify windings in DC motors.	1, 3, 4	XII-A-5	ELA-5-H1, H2, H3, H4, H5, H6
F. Explain means for providing for field failure, current limit, voltage, and speed control.	1, 3, 4	XII-A-6	ELA-7-H1, H2
G. Explain block diagrams to demonstrate power supplies, armature field and control features.	1, 3, 4	XII-A-7	Mathematics
H. Define <i>torque</i> , <i>locked rotor current</i> , <i>no-load speed</i> , and <i>slip</i> .	1, 3, 4	XII-A-8	N-1H, 2H, 3h, 4H, 5H, 7H
I. Explain reasons for low voltage starting.	1, 3, 4	XII-A-9	A-1H, 2H, 3H, 4H
J. Explain the function, operation, and characteristics of stepping motors.	1, 2, 3, 4	XII-A-10	M-1H, 2H, 3H, 4H
		XII-B	G-1H, 2H, 3H, 5H, 6H
		XII-B-1	D-2H, 4H, 7H, 8H, 9H
		XII-B-2	Social Studies
		XII-B-3	G-1C-H2, 1D-H1, 1D-H2, 1D-H4
		XII-B-4	E-1A-H1, 1A-H2, 1A-H3, 1A-H6, 1B-H1,
		XII-B-5	1B-H2, 1B-H4, 1B-H6
II. PROPER TECHNIQUES FOR MOTOR INSTALLATIONS	1, 2, 3, 4	XII-B-6	Science
A. Perform the necessary calculations for electrical requirements per code.	1, 3, 4	XII-B-7	PS-H-B1, PS-H-E1, PS-H-F1, PS-H-F2,
B. Determine the correct power factor.	1, 3, 4	XII-C	PS-H-G2, PS-H-G3, PS-H-G4, SE-H-D2,
C. Select proper wire type and size.	1, 3, 4	XII-C-1	SE-H-D6
D. Select appropriate connections.	1, 2, 3, 4	XII-C-2	
E. Explain how various motors can be made to run at a different speed or reverse direction.	1, 3, 4	XII-C-3, 4	
F. Identify unmarked motor leads.	1, 3, 4	XII-C-5	
G. Explain steps for proper handling of motors.	1, 3, 4	XII-C-6	
		XII-C-7	
III. FUNCTIONS, OPERATIONS, AND CHARACTERISTICS OF MOTOR CONTROLLERS, CIRCUITS AND DEVICES			
A. Explain ways and means of starting and stopping motors.			
B. Explain the operation of magnetic coil.			
C. Explain the correct sizing use of magnetic starters and controllers.			
D. Explain the difference between starters and contactors.			
E. Explain the function, operation, and characteristics of thermal and magnetic overload protective devices.			
F. Interpret schematics for various control circuits.			
G. Explain the use of two wire and three wire	1, 3, 4	XII-C-8, 9	English Language Arts (ELA)

Benchmarks	Louisiana Foundation Skills	National Skill Standard	Academic Cross-Reference (Standard-Benchmark)
control circuits.	1, 3, 4	XII-C-10	ELA 1-H1, H3, H4, H5
H. Explain interlocking methods.	1, 3, 4	XII-C-11	ELA 2-H2, H3
I. Explain the operation of reversing and sequential controllers.	1, 3, 4	XII-C-12	ELA 3-H2, H3
J. Explain jogging, inching and plugging.	1, 3, 4	XII-C-13	ELA 4-H1, H2, H3, H4, H5, H6
K. Explain the operation of multiple start stop controls and selector switches.	1, 2, 3, 4	XII-C-14	ELA 5-H1, H2, H3, H6
L. Explain the operation of phase failure relays.	1, 3, 4	XII-C-15	ELA 7-H1, H2
M. Explain various manual and automatic speed control techniques.	1, 2, 3, 4	XII-C-16	Mathematics
N. Explain the function, operation, and characteristics of variable frequency drives.	1, 2, 3, 4	XII-C-17	N-1H, 2H, 3H, 4H, 5H, 6H, 7H
O. Explain function, operation, characteristics and installation procedures for programmable logic controls.	1, 2, 3, 4	XII-C-18	A-1H, 2H, 3H, 4H
P. Interpret ladder diagrams.	1, 2, 3, 4	XII-C-19	M-1H, 2H, 3H, 4H
Q. Explain function, operation, and characteristics of timers, counters, and sequencers.	1, 2, 3, 4	XII-C-20	D-7H, 9H
R. Utilize appropriate manuals and information for start-up, maintenance and testing.	1, 2, 3, 4	XII-C-21	G-1H, 2H, 3H, 4H, 5H, 6H
S. Utilize schematics for manual starters, automatic starters, speed regulators and controllers.	1, 2, 3, 4	XII-D	Social Studies
IV. FUNCTIONS, OPERATIONS, AND CHARACTERISTICS OF SWITCHES AND RELAYS	1, 2, 3, 4	XII-D-1	G-1D-H1, 1D-H2, 1D-H4
A. Interpret schematics that include switches and relays.	1, 2, 3, 4	XII-D-2	C-1A-H1, 1A-H5
B. Explain and perform installation and connection methods for various switch types.	1, 2, 3, 4	XII-D-3	E-1A-H1, 1A-H2, 1A-H3, 1A-H6
C. Explain and perform installation and connection for various relays.	1, 2, 3, 4	XII-D-4	1B-H1, 1B-H2, 1B-H4, 1B-H5, 1B-H6
D. Explain the function, operation, and characteristics of electronic sensor and pilot devices.	1, 2, 3, 4	XII-D-5	Science
E. Explain the function, operation, and characteristics of control transformers.-			PS-H-B1, E1, F1, F2, G1, G2, G3, G4, G5
			ESS-H-A1
			SE-H-A11, B1, B6, C2, C4, C5, D1, D2, D3,
			D4, D5, D6

Benchmarks	Louisiana Foundation Skills	National Skill Standard	Academic Cross-Reference (Standard-Benchmark)
V. MECHANICAL CONNECTIONS TO UTILIZE MOTORS A. Explain the operation of mechanical clutches and magnetic drives. B. Explain the function, operation, characteristics and installation of closed loop and open loop systems, feedback controls, proportional controls, integral controls, and derivative controls. C. Interpret block diagrams including control systems and devices. D. Explain the function, operation, and characteristics of sensors and transmitters.	1, 3, 4 1, 3, 4 1, 3, 4 1, 2, 3, 4	XII-E XII-E-1 XII-E-2 XII-E-3 XII-E-4 XII-F XII-F-1 XII-F-2	English Language Arts (ELA) ELA 1-H1, H3, H4, H5 ELA 2-H2, H3 ELA 3-H2, H3 ELA 4-H1, H2, H3, H4, H5, H6 ELA 5-H1, H2, H3, H6 ELA 7-H1, H2 Mathematics N-1H, 2H, 3H, 4H, 5H, 6H, 7H A-1H, 2H, 3H, 4H M-1H, 2H, 3H, 4H D-7H, 9H G-1H, 2H, 3H, 4H, 5H, 6H Social Studies G-1D-H1, 1D-H2, 1D-H4 C-1A-H1, 1A-H5 E-1A-H1, 1A-H2, 1A-H3, 1A-H6 1B-H1, 1B-H2, 1B-H4, 1B-H5, 1B-H6 Science PS-H-B1, E1, F1, F2, G1, G2, G3, G4, G5 ESS-H-A1 SE-H-A11, B1, B6, C2, C4, C5, D1, D2, D3, D4, D5, D6
VI. PROCESS CONTROL SYSTEMS DEVICES A. Determine operating requirements followed by manual and automatic controllers. B. Explain the function, operation, characteristics and installation of closed loop and open loop systems, feedback controls, proportional controls, integral controls, and derivative controls. C. Interpret block diagrams including control systems and devices. D. Explain the function, operation and characteristics of sensors and transmitters	1, 3, 4 1, 2, 3, 4	XII-F-3 XII-F-4	

M. Standard 13: Explain the Operation and Applications of Generators and Power Supplies

Benchmarks	Louisiana Foundation Skills	National Skill Standard	Academic Cross-Reference (Standard-Benchmark)
I. EXPLAIN ELECTROMOTIVE FORCE II. PRINCIPLES OF GENERATING ELECTRICITY A. Explain the construction, function, operation, and characteristics of the AC generator. B. Explain the construction, function, operation, and characteristics of the DC generator. C. Explain the “left hand rule” for generators. D. Determine the RPM, frequency and number of poles on a given generator. E. Explain three phase generator. F. Explain wye and delta windings.	1, 3, 4 1, 3, 4 1, 3, 4 1, 3, 4 1, 3, 4 1, 3, 4 1, 2, 3, 4 1, 2, 3, 4	XIII-A XIII-B XIII-B-1 XIII-B-2 XIII-B-3 XIII-B-4 XIII-B-5 XIII-B-6 XIII-B-7 XIII-C	English Language Arts (ELA) ELA 1-H1, H3, H4, H5 ELA 2-H2, H3 ELA 3-H2, H3 ELA 4-H1, H2, H3, H4, H5, H6 ELA 5-H1, H2, H3, H6 ELA 7-H1, H2 Mathematics N-1H, 2H, 3H, 4H, 5H, 6H, 7H A-1H, 2H, 3H, 4H M-1H, 2H, 3H, 4H D-7H, 9H G-1H, 2H, 3H, 4H, 5H, 6H

Benchmarks	Louisiana Foundation Skills	National Skill Standard	Academic Cross-Reference (Standard-Benchmark)
<p>G. Explain three phase sine wave.</p> <p>III. EXPLAIN TYPES, CONFIGURATIONS, AND OPERATION OF UNINTERRUPTIBLE POWER SUPPLIES (UPS)</p> <p>IV. EXPLAIN THE TYPES, CONFIGURATIONS, AND OPERATION OF BATTERY SYTEMS USED FOR UPS SYSTEMS</p>		XIII-D	<p>Social Studies G-1D-H1, 1D-H2, 1D-H4 C-1A-H1, 1A-H5 E-1A-H1, 1A-H2, 1A-H3, 1A-H6 1B-H1, 1B-H2, 1B-H4, 1B-H5, 1B-H6</p> <p>Science PS-H-B1, E1, F1, F2, G1, G2, G3, G4, G5 ESS-H-A1 SE-H-A11, B1, B6, C2, C4, C5, D1, D2, D3, D4, D5, D6</p>

N. Standard 14: Explain the Operation, Selection and Use of Transformers

Benchmarks	Louisiana Foundation Skills	National Skill Standard	Academic Cross-Reference (Standard-Benchmark)
<p>I. FUNCTION, OPERATION, AND CHARACTERISTICS OF TRANSFORMERS</p> <p>A. Explain the electrical principles governing transformer operation.</p> <p>B. Explain the classification of transformer and application criteria.</p> <p>C. Explain transformer losses.</p> <p>D. Determine ratios for voltage and amperage with respect to turns.</p> <p>II. SELECTION AND INSTALLATION OF TRANSFORMERS</p> <p>A. Interpret nameplate information.</p> <p>B. Describe the techniques for sizing transformers (single and three phase).</p> <p>C. Determine whether a transformer meets voltage, current, and impedance requirements.</p> <p>D. Calculate voltages and currents for load and windings.</p> <p>E. Determine the use of wye or delta wiring schemes.</p> <p>F. List and explain the steps for receiving and preparing transformers for installation.</p> <p>G. Perform tests to assure proper operation.</p> <p>H. Explain the proper techniques for connecting power and load conductors.</p> <p>I. Explain the methods for determining the proper types and values of electrical protective devices.</p> <p>J. Describe proper grounding procedures.</p>	<p>1, 2, 3, 4</p> <p>1, 2, 3</p> <p>1, 2, 3</p> <p>1, 2, 3</p> <p>1, 2, 3</p> <p>1, 2, 3</p> <p>1, 2, 3</p> <p>1, 2, 3</p> <p>1, 2, 3</p> <p>1, 2, 3</p> <p>1, 2, 3</p> <p>1, 2, 3</p> <p>1, 2, 3</p> <p>1, 2, 3</p> <p>1, 2, 3</p> <p>1, 2, 3</p> <p>1, 2, 3</p> <p>1, 2, 3</p> <p>1, 2, 3</p> <p>1, 2, 3</p> <p>1, 2, 3</p>	<p>XIV-A</p> <p>XIV-A-1</p> <p>XIV-A-2</p> <p>XIV-A-3</p> <p>XIV-A-4</p> <p>XIV-B</p> <p>XIV-B-1</p> <p>XIV-B-2</p> <p>XIV-B-3</p> <p>XIV-B-4</p> <p>XIV-B-5</p> <p>XIV-B-6</p> <p>XIV-B-7</p> <p>XIV-B-8</p> <p>XIV-B-9</p> <p>XIV-B-10</p> <p>XIV-C</p> <p>XIV-C-1</p> <p>XIV-C-2</p>	<p>English Language Arts (ELA) ELA 1-H1, H3, H4, H5 ELA 2-H2, H3 ELA 3-H2, H3 ELA 4-H1, H2, H3, H4, H5, H6 ELA 5-H1, H2, H3, H6 ELA 7-H1, H2</p> <p>Mathematics N-1H, 2H, 3H, 4H, 5H, 6H, 7H A-1H, 2H, 3H, 4H M-1H, 2H, 3H, 4H D-7H, 9H G-1H, 2H, 3H, 4H, 5H, 6H</p> <p>Social Studies G-1D-H1, 1D-H2, 1D-H4 C-1A-H1, 1A-H5 E-1A-H1, 1A-H2, 1A-H3, 1A-H6 1B-H1, 1B-H2, 1B-H4, 1B-H5, 1B-H6</p> <p>Science PS-H-B1, E1, F1, F2, G1, G2, G3, G4, G5 ESS-H-A1 SE-H-A11, B1, B6, C2, C4, C5, D1, D2, D3, D4, D5, D6</p>

Benchmarks	Louisiana Foundation Skills	National Skill Standard	Academic Cross-Reference (Standard-Benchmark)
III. DISTRIBUTION SYSTEMS A. Explain the function, operation, and characteristics of various types of distribution systems. B. Explain the criteria for selecting distribution systems.			

O. Standard 15: Personal Development of Electricians

Benchmarks	Louisiana Foundation Skills	National Skill Standard	Academic Cross-Reference (Standard-Benchmark)
I. ORIENTATION A. Explain the organization of the industry from the customer to the contractor. B. Explain the various organizations within the industry, including those that represent manufacturers, distribution, associations, and unions.	1, 2, 3 1, 2, 3	XV-A XV-A-1 XV-A-2	English Language Arts (ELA) ELA 1-H1, H3, H4, H5 ELA 2-H2, H3 ELA 3-H2, H3 ELA 4-H1, H2, H3, H4, H5, H6 ELA 5-H1, H2, H3, H6 ELA 7-H1, H2
II. METHODS OF WORKING WITH OTHERS A. Explain the three basis theories of motivation. B. Explain the need levels of humans. C. Explain the role of the supervisors. D. Explain the need for effective communication in electrical work.	1, 2, 3, 4, 5 1, 2, 3, 4, 5 1, 2, 3, 4, 5 1, 2, 3, 4, 5 1, 2, 3 1, 2, 3 1, 2, 3, 4	XV-B XV-B-1 XV-B-2 XV-B-3 XV-B-4 XV-C XV-C-1 XV-C-2 XV-C-3	Mathematics N-1H, 2H, 3H, 4H, 5H, 6H, 7H A-1H, 2H, 3H, 4H M-1H, 2H, 3H, 4H D-7H, 9H G-1H, 2H, 3H, 4H, 5H, 6H
III. ECONOMIC CONSIDERATIONS A. Explain how the future of the worker is tied to that of the employer. B. Explain the electrical workers responsibility to the employer. C. Explain the costs of doing business. D. Explain the importance of satisfying the customers. E. Explain the impact of job performance, behavior, and appearance on the prospects for future work. F. Explain the function of marketing within the field.	1, 2, 3 1, 2, 3 1, 2, 3 1, 2, 3	XV-C-4 XV-C-5 XV-C-6	Social Studies G-1D-H1, 1D-H2, 1D-H4 C-1A-H1, 1A-H5 E-1A-H1, 1A-H2, 1A-H3, 1A-H6 1B-H1, 1B-H2, 1B-H4, 1B-H5, 1B-H6 Science PS-H-B1, E1, F1, F2, G1, G2, G3, G4, G5 ESS-H-A1 SE-H-A11, B1, B6, C2, C4, C5, D1, D2, D3, D4, D5, D6

P. Standard 16: Explain Effective Jobsite Management Techniques

Benchmarks	Louisiana Foundation Skills	National Skill Standard	Academic Cross-Reference (Standard-Benchmark)
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Benchmarks	Louisiana Foundation Skills	National Skill Standard	Academic Cross-Reference (Standard-Benchmark)
I. COORDINATE TOOL NEEDS WITH OFFICE OF OTHER JOBS. II. COORDINATE THE SCHEDULING OF JOBS WITH OTHER CRAFTS. III. DEVELOP TIMETABLE AND PROGRESS CHART. IV. COMPLETE TIME SHEETS, LOG, AND OTHER FORM OF DOCUMENTATION. V. EXPLAIN THE PROECDURE OF OBTAINING CLEARANCE OR PERMITS. VI. PERFORM INVENTORY AND COMPLETE ORDERS FOR EQUIPMENT ACCORDING TO JOB NEEDS. VII.DEVELOP ALTERNATIVE SOLUTION TO PROBLEMS AND CHOOSE THE MOST APPROPRIATE. VIII. PLAN AND ORGANIZE TASKS TO MEET DEADLINE. IX. SUPERVISE AND MONITOR OTHERS ON THE JOBSITE. X. PICTURE THE WAY A JOB WILL APPEAR WHEN COMPLETED	1, 2, 3, 4 1, 2, 3 1, 2, 3, 4 1, 2, 3, 4 1, 2, 3 1, 2, 3 1, 2, 3 1, 2, 3 1, 2, 3 1, 2, 3 1, 2, 3	XVI-A XVI-B XVI-C XV-D XVI-E XVI-F XVI-G XVI-H XVI-I XVI-J	English Language Arts (ELA) ELA 1-H1, H3, H4, H5 ELA 2-H2, H3 ELA 3-H2, H3 ELA 4-H1, H2, H3, H4, H5, H6 ELA 5-H1, H2, H3, H6 ELA 7-H1, H2 Mathematics N-1H, 2H, 3H, 4H, 5H, 6H, 7H A-1H, 2H, 3H, 4H M-1H, 2H, 3H, 4H D-7H, 9H G-1H, 2H, 3H, 4H, 5H, 6H Social Studies G-1D-H1, 1D-H2, 1D-H4 C-1A-H1, 1A-H5 E-1A-H1, 1A-H2, 1A-H3, 1A-H6 1B-H1, 1B-H2, 1B-H4, 1B-H5, 1B-H6 Science PS-H-B1, E1, F1, F2, G1, G2, G3, G4, G5 ESS-H-A1 SE-H-A11, B1, B6, C2, C4, C5, D1, D2, D3,D4, D5, D6

Q. Standard 17: Explain and Perform Various Test Procedures with the Appropriate Equipment

Benchmarks	Louisiana Foundation Skills	National Skill Standard	Academic Cross-Reference (Standard-Benchmark)
I. STEPS USED FOR VARIOUS TEST PROCEDURES A. Perform acceptance testing of cable. B. Perform maintenance tests on generators. C. Perform insulation tests using the megohmmeter. II. UTILIZING THE RESULTS OF TESTING PROCEDURES A. Explain the special requirements for high voltage testing. B. Describe the safety hazards encountered in testing. C. Explain the characteristics and properties of high voltage cable and insulators. D. Perform appropriate test methods using	1, 2, 3, 4 1, 2, 3, 4 1, 2, 3, 4 1, 3, 4 1, 2, 3, 4, 5 1, 2, 3, 4 1, 3, 4	XVII-A XVII-A-1 XVII-A-2 XVII-A-3 XVII-B XVII-B-1 XVII-B-2 XVII-B-3 XVII-B-4	English Language Arts (ELA) ELA 1-H1, H3, H4, H5 ELA 2-H2, H3 ELA 3-H2, H3 ELA 4-H1, H2, H3, H4, H5, H6 ELA 5-H1, H2, H3, H6 ELA 7-H1, H2 Mathematics N-1H, 2H, 3H, 4H, 5H, 6H, 7H A-1H, 2H, 3H, 4H M-1H, 2H, 3H, 4H D-7H, 9H G-1H, 2H, 3H, 4H, 5H, 6H

Benchmarks	Louisiana Foundation Skills	National Skill Standard	Academic Cross-Reference (Standard-Benchmark)
various equipment.			<p>Social Studies G-1D-H1, 1D-H2, 1D-H4 C-1A-H1, 1A-H5 E-1A-H1, 1A-H2, 1A-H3, 1A-H6 1B-H1, 1B-H2, 1B-H4, 1B-H5, 1B-H6</p> <p>Science PS-H-B1, E1, F1, F2, G1, G2, G3, G4, G5 ESS-H-A1 SE-H-A11, B1, B6, C2, C4, C5, D1, D2, D3, D4, D5, D6</p>

R. Standard 18: Explain the Use of Electrical Specialty Systems

Benchmarks	Louisiana Foundation Skills	National Skill Standard	Academic Cross-Reference (Standard-Benchmark)
I. FIRE ALARMS A. Explain the function, operation, and characteristics of various types of fire alarm systems and components. B. Apply code requirements to fire alarm system design and construction. C. Explain the function, operation, and characteristics of alarm initiating and indicating devices. D. Explain multiplexing of system components. E. Explain methods of providing fire protection for various types of areas. F. Select appropriate wiring methods and devices for various jobs and make installation. G. Use manuals and perform check out and start-up procedures. H. Use manuals and determine system maintenance requirements and for troubleshooting.	1, 2, 3 1, 2, 3, 4 1, 2, 3, 4 1, 2, 3, 4 1, 2, 3, 4 1, 2, 3, 4 1, 2, 3, 4 1, 2, 3, 4	XVIII-A XVIII-A-1 XVIII-A-2 XVIII-A-3 XVIII-A-4 XVIII-A-5 XVIII-A-6 XVIII-A-7 XVIII-A-8 XVIII-B XVIII-B-1 XVIII-B-2 XVIII-B-3 XVIII-B-4 XVIII-B-5 XVIII-B-6 XVIII-B-7 XVIII-B-8	<p>English Language Arts (ELA) ELA 1-H1, H3, H4, H5 ELA 2-H2, H3 ELA 3-H2, H3 ELA 4-H1, H2, H3, H4, H5, H6 ELA 5-H1, H2, H3, H6 ELA 7-H1, H2</p> <p>Mathematics N-1H, 2H, 3H, 4H, 5H, 6H, 7H A-1H, 2H, 3H, 4H M-1H, 2H, 3H, 4H D-7H, 9H G-1H, 2H, 3H, 4H, 5H, 6H</p> <p>Social Studies G-1D-H1, 1D-H2, 1D-H4 C-1A-H1, 1A-H5 E-1A-H1, 1A-H2, 1A-H3, 1A-H6 1B-H1, 1B-H2, 1B-H4, 1B-H5, 1B-H6</p> <p>Science PS-H-B1, E1, F1, F2, G1, G2, G3, G4, G5 ESS-H-A1 SE-H-A11, B1, B6, C2, C4, C5, D1, D2, D3, D4, D5, D6</p>
II. SECURITY SYSTEMS A. Explain the function, operation, and characteristics of various types of security systems and components. B. Apply code requirements to security system design and construction. C. Explain the function, operation, and characteristics of alarm initiating and indicating devices. D. Explain multiplexing of system components. E. Explain methods of providing security systems for various types of areas. F. Select appropriate wiring methods and devices	1, 2, 3, 4 1, 2, 3, 4 1, 2, 3, 4 1, 2, 3, 4 1, 2, 3, 4 1, 2, 3, 4 1, 2, 3, 4 1, 2, 3, 4 1, 2, 3, 4 1, 2, 3, 4 1, 2, 3, 4 1, 2, 3, 4 1, 2, 3, 4 1, 2, 3, 4	XVIII-B-4 XVIII-B-5 XVIII-B-6 XVIII-B-7 XVIII-B-8	

Benchmarks	Louisiana Foundation Skills	National Skill Standard	Academic Cross-Reference (Standard-Benchmark)
and make installation. G. Use manuals and perform check out and start-up procedures. H. Use manuals and determine system maintenance requirements and for troubleshooting.			
III. VOICE, DATA, AND SIGNALING SYSTEMS		XVIII-C	
A. Explain the function, operation, and characteristics of various types of voice, data, TV and signaling systems.	1, 2, 3, 4, 5	XVIII-C-1	
	1, 3, 4	XVIII-C-2	
B. Explain the proper cabling systems required for various systems.	1, 3, 4	XVIII-C-3	
	1, 2, 3, 4	XVIII-C-4	
C. Perform installation and connection techniques for cables and devices.	1, 2, 3, 4	XVIII-C-5	
D. Explain how cable defects and installation errors can degrade data transfer.	1, 2, 3, 4	XVIII-C-6	
E. Use manuals to install, test, start and check out systems.			
F. Use appropriate manuals and techniques for system maintenance and troubleshooting.			
IV. LIGHTNING PROTECTION SYSTEMS		XVIII-D	
A. Explain the function, operation, and characteristics of lightning protection systems.	1, 2, 3, 4	XVIII-D-1	
B. Determine the sizing, layout and installation protection systems.	1, 2, 3, 4	XVIII-D-2	
	1, 2, 3, 4	XVIII-D-3	
C. Apply Code requirements to lightning protection systems.	1, 2, 3, 4	XVIII-D-4	
	1, 2, 3, 4	XVIII-D-5	
D. Determine the size of conductors and electrodes.	1, 2, 3, 4	XVIII-D-6	
E. Install electrodes.		XVIII-E	
F. Install conductors and make connections to electrodes.	1, 2, 3, 4	XVIII-E-1	
V. FIBER OPTIC SYSTEMS	2, 3, 4	XVIII-E-2	
A. Explain the function, operation, and characteristics of fiber optic cable.	1, 2, 4	XVIII-E-3	
B. Demonstrate proper installation techniques such as the installation of hardware and splicing and termination.		XVIII-F	
	1, 2, 3, 4, 5	XVIII-F-1	
C. Use appropriate manuals and equipment to perform systems tests and troubleshooting procedures.	1, 3, 4	XVIII-F-2	
	1, 3, 4	XVIII-F-3	
	1, 3, 4	XVIII-F-4	
VI. HEATING, AIR CONDITIONING, AND REFRIGERATION			
A. Explain the function, operation, and characteristics of heating, air conditioning, and refrigeration systems and their components.	1, 3, 4	XVIII-F-5	
	1, 2, 3, 4	XVIII-F-6	
B. Explain the characteristics of heat energy, transfer and measurement.			
C. Explain and contrast space and process heating.			
D. Compare and contrast the properties and characteristics of refrigerant.			
E. Explain the appropriate piping techniques for			

Benchmarks	Louisiana Foundation Skills	National Skill Standard	Academic Cross-Reference (Standard-Benchmark)
refrigerants. F. Use appropriate manuals and equipment to perform system tests and troubleshooting procedures.			

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10) and R.S. 17:10.

HISTORICAL NOTE: Promulgated by the Department of Education, Board of Elementary and Secondary Education, Trade and Industrial Education, LR 31:

Subpart 7. Heating, Ventilating, Air-Conditioning, and Refrigeration (HVACR)
Chapter 21. Introduction
§2101. Heating, Ventilating, Air-Conditioning, and Refrigeration (HVACR) Excellence
Rationale

Note: All references to HVACR include refrigeration throughout this Subpart 13.

A. See Subpart 1 of this Part XCIX for General Provisions applicable to this Heating, Ventilating, Air Conditioning, and Refrigeration (HVACR) Program.

B. Heating, Ventilating, Air-Conditioning, and Refrigeration (HVACR) Excellence Certification provides national recognition of a technician's skill levels. It is a comprehensive series of exams built around a universally accepted benchmark of technical expertise. Various levels of certification allow HVACR Excellence to be very specific in fulfilling the demand for qualified personnel and in projection of a professional image.

C. Industry records reflect that over 85 percent of all service calls and troubleshooting scenarios involve electrical problems. For this reason, the electrical certification examination is a prerequisite to all other HVACR Excellence certifications. Each advancing level of certification builds on the foundation established by the electrical exam.

D. A technician who has achieved electrical certification may advance to the heating examinations or to the air conditioning exam.

E. Air conditioning certification is prerequisite to the commercial air conditioning, commercial Refrigeration, and to the heat pump exams. (The heat pump certification covers the competencies necessary for servicing air-to-air heat pumps, and is a prerequisite to the geo-thermal exam.)

F. Due to regional and climatic variations, and in order to make the exams more detailed, heating systems certifications are not packaged as one test. Heating exams are divided into five types. Technicians may choose any or all of the five categories:

1. Gas Heat;
2. Electric Heat;
3. Oil Heat;
4. Hydronics I (Hot Water); and
5. Hydronics II (Steam).

G. By providing a multi-tiered program, a technician is both rewarded for accomplishments and is also motivated to advance. Each level of certification covers the skills necessary to instill confidence in the technician's competencies, improve his/her proficiency on each job assignment, and project an image of professionalism to customers.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10) and R.S. 17:10.

HISTORICAL NOTE: Promulgated by the Department of Education, Board of Elementary and Secondary Education, Trade and Industrial Education, LR 31:

Chapter 23. Certification

§2301. Technician Certification—“The Benchmark of Technical Excellence”

A. HVACR Excellence is a nonprofit organization established by a grant from the ESCO Institute. The two primary responsibilities of HVACR Excellence are:

1. technician competency certification; and
2. program accreditation.

B. The HVACR Excellence Technician Competency Certification Program is designed to reflect the competencies set forth by various organizations such as the National Skills Standards Board, the Manufacturers Skills Standards Council and Vocational Technical Education Consortium of States (VTECHS).

C. ESCO Institute supports online testing services through its worldwide network of more than 6,000 test administrators. ESCO Institute works with manufacturers, skilled technicians, contractors, and educators to develop programs that support national recognition and certification standards for schools and HVACR professionals. The HVACR Excellence exams are designed to establish a universally accepted benchmark of technical excellence.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10) and R.S. 17:10.

HISTORICAL NOTE: Promulgated by the Department of Education, Board of Elementary and Secondary Education, Trade and Industrial Education, LR 31:

§2303. Electrical Certification

A. This certification has been designed to directly address the needs of the HVACR technician who has the responsibility of installing, servicing, troubleshooting, and repairing the various electrical circuits and components of today's HVACR systems. Because the vast majority of service calls involve electrical repairs, Electrical Certification has been selected as the prerequisite over all other certifications in the HVACR Excellence Program. Other certifications may contain electrical questions specific to that exam.

B. Who Should Be Certified. With an extreme emphasis on safety, *anyone* responsible for the installation, service or maintenance of HVACR equipment must have a working knowledge of electrical systems.

C. Competencies covered:

1. circuit fundamentals;
2. electrical materials;
3. magnetism;
4. circuit protection;
5. types of electric motors;
6. troubleshooting basic controls;
7. troubleshooting electric motors;
8. motor controls;
9. application of motors;
10. automatic controls components and applications.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10) and R.S. 17:10.

HISTORICAL NOTE: Promulgated by the Department of Education, Board of Elementary and Secondary Education, Trade and Industrial Education, LR 31:

§2305. Air Conditioning Certification

A. Air conditioning (A/C) certification establishes a basis for all other certifications involving the vapor compression refrigeration system. Today's systems use new refrigerants and oils compared to units built just a few years ago. A properly maintained system should deliver years of trouble-free operation. However, improper service techniques or failure of one simple component will almost always lead to catastrophic failure of the system.

B. Who Should Be Certified. Any technician responsible for diagnosis and repair must possess a strong background in refrigeration systems.

C. Competencies covered:

1. theory of heat, temperature, and pressure;
2. physical states of matter and change of state;
3. refrigeration and refrigerants;
4. refrigerant and oil management;
5. refrigeration applied to air conditioning;
6. system evacuation;
7. leak detection;
8. tubing and piping practices;
9. tool usage and calibration;
10. equipment maintenance;
11. system charging;
12. safety.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10) and R.S. 17:10.

HISTORICAL NOTE: Promulgated by the Department of Education, Board of Elementary and Secondary Education, Trade and Industrial Education, LR 31:

§2307. Commercial Refrigeration Certification

A. Electrical and air conditioning certification is a prerequisite to commercial refrigeration. The commercial refrigeration technician will be faced with a variety of equipment and an equal variety of troubleshooting and service situations. It is important to remember that all of the equipment has certain components and functions that are common to all refrigeration and A/C devices. Knowing how a system or component is supposed to function under typical conditions will greatly aid in solving malfunctions.

B. Who Should Be Certified. Technician servicing and maintaining commercial or industrial refrigeration systems should be certified.

C. Competencies covered:

1. refrigeration components;
2. commercial evaporators;
3. commercial condensing units;
4. head pressure controls;
5. charging commercial systems;
6. grocery (reach-in) cabinets;
7. walk-in cabinets;
8. industrial applications;
9. pressure regulating valves;
10. ice maker controls;
11. defrost timers;
12. refrigerant controls;

13. dispensing freezers;
14. frozen food storage;
15. display cases.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10) and R.S. 17:10.

HISTORICAL NOTE: Promulgated by the Department of Education, Board of Elementary and Secondary Education, Trade and Industrial Education, LR 31:

§2309. Commercial Air Conditioning Certification

A. Electrical and air conditioning certification is a prerequisite to commercial air conditioning. Commercial air conditioning technicians will be faced with a variety of equipment and systems. It is important to remember that all of the equipment has certain components and functions that are common to all refrigeration and A/C devices. Commercial buildings may experience high occupancy and contain a variety of equipment leading to indoor air quality (IAQ) concerns. This certification addresses the unique issues involved in the service and maintenance of commercial air conditioning systems.

B. Who Should be Certified. Anyone servicing commercial air conditioning systems should be certified.

C. Competencies covered:

1. commercial evaporators;
2. commercial condensing units;
3. head pressure controls;
4. filtration;
5. HEPA filters;
6. electronic air filters;
7. activated charcoal air purifiers;
8. charging commercial systems;
9. air distribution;
10. fresh air intake and exchange;
11. ion generators;
12. humidity control;
13. controlling indoor contamination;
14. duct cleaning.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10) and R.S. 17:10.

HISTORICAL NOTE: Promulgated by the Department of Education, Board of Elementary and Secondary Education, Trade and Industrial Education, LR 31:

§2311. Heat Pump Certification

A. This certification will demonstrate the technician's competencies in all areas of service and troubleshooting air-to-air heat pump systems. Technicians seeking the heat pump certification will have satisfactorily completed the electrical and air conditioning certifications prior to taking this test. The heat pump certification is a prerequisite for geo-thermal certification.

B. Who Should Be Certified. Any technician responsible for the installation, service and maintenance of air-to-air heat pump systems should be heat pump certified.

C. Competencies covered:

1. theory, operations and components of a reverse cycle heat pump;

2. four way valves;
3. heat sources for heat pumps;
4. co-efficiency of performance;
5. safety;
6. heat pump efficiency ratings;
7. auxiliary heat for heat pumps;
8. control sequences;
9. maintenance procedures.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10) and R.S. 17:10.

HISTORICAL NOTE: Promulgated by the Department of Education, Board of Elementary and Secondary Education, Trade and Industrial Education, LR 31:

§2313. Geothermal Certification

A. The geothermal certification concentrates on open loop (water source), and closed loop (earth-coupled) systems. Electrical, air conditioning, and the heat pump certifications are required prior to taking this exam.

B. Who Should be Certified. Any technician responsible for the installation, service and maintenance of geothermal heat pump systems should be geothermal certified.

C. Competencies covered:

1. open loop and closed loop geothermal systems;
2. water quality requirements;
3. ground loop configurations;
4. series and parallel flow configurations;
5. formulas for calculation of absorption and rejection of heat;
6. well types and water sources;
7. system fluids and heat exchanger materials;
8. maintenance procedures;
9. safety.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10) and R.S. 17:10.

HISTORICAL NOTE: Promulgated by the Department of Education, Board of Elementary and Secondary Education, Trade and Industrial Education, LR 31:

§2315. Gas Heat Certification

A. Gas heat systems have changed dramatically in the past few years. Many of the new high efficiency gas-heating units employ electronic ignition systems, variable speed motors, and a myriad of electronic controls. In addition to a solid foundation in the theory and operations of older existing systems, today's technician must possess the skills to service these newer systems to ensure safe and trouble-free operation. Gas heat certification indicates that a technician possesses an in-depth knowledge of all types of gas heat units and their control systems.

B. Who Should Be Certified. Electrical certification is prerequisite to the gas heat exam. Any technician who installs, services, or maintains gas heat systems should be certified.

C. Competencies covered:

1. types of furnaces;
2. gas fuels;
3. natural gas/LP gas;

4. combustion;
5. gas valve;
6. gas furnace wiring diagrams;
7. manifold;
8. orifice;
9. burners;
10. pilots;
11. automatic combination gas valve;
12. troubleshooting techniques.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10) and R.S. 17:10.

HISTORICAL NOTE: Promulgated by the Department of Education, Board of Elementary and Secondary Education, Trade and Industrial Education, LR 31:

§2317. Electric Heat Certification

A. Electric heat certification demonstrates the technician's competencies in all aspects of service and troubleshooting electric heat systems. Electric heat is commonly used as a supplemental heat supply for heat pump systems and therefore makes an excellent supporting certification.

B. Who Should Be Certified. Electrical certification is a prerequisite to the electric heat exam. A technician who services electric heat systems or heat pump systems should be electric heat certified.

C. Competencies covered:

1. principles of electric resistance heating;
2. central forced air electric furnaces;
3. controlling multiple stages;
4. contactors for electric furnaces;
5. thermostats;
6. wiring diagrams;
7. fan motor circuits;
8. airflow.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10) and R.S. 17:10.

HISTORICAL NOTE: Promulgated by the Department of Education, Board of Elementary and Secondary Education, Trade and Industrial Education, LR 31:

§2319. Oil Heat Certification

A. Oil heat requires more consistent regular service than any other heat system. The fuel oil must be properly metered and burned for best efficiency. Improper burning efficiency will cause soot to form, which will slow down the heat exchange process and decrease the burning efficiency. Yearly preventive maintenance procedures, from the oil tank to the flue, must be performed.

B. Who Should Be Certified. Electrical certification is a prerequisite to the oil heat exam. Any technician responsible for service or maintenance of oil heat systems should be certified.

C. Competencies covered:

1. fuel oils;
2. combustion products and byproducts;

3. combustion efficiency;
4. gun type oil burners;
5. nozzles;
6. preventative maintenance;
7. basic service procedures;
8. ignition system;
9. oil burner components;
10. fuel oil pumps.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10) and R.S. 17:10.

HISTORICAL NOTE: Promulgated by the Department of Education, Board of Elementary and Secondary Education, Trade and Industrial Education, LR 31:

§2321. Hydronics I and II Certification

A. Hydronic heating systems use hot water (Hydronics I) or steam (Hydronics II) to carry heat to occupied spaces. Such systems have been in use for many years. Today's systems employ various piping arrangements to allow for zoned heat controls. Many of these zoned systems use microprocessor controls to allow different heat level to the areas being heated. The heat exchange units vary from the old stand-up radiators, to baseboard units or in-floor radiant heat systems.

B. Who Should Be Certified. Electrical Certification is a prerequisite to the Hydronics Heat Certifications. Technicians who service or maintain hot water heating systems should be certified in Hydronics I. Technicians who service or maintain steam heating systems should be certified in Hydronics II. It is highly recommended, but not required, that technicians have at least one other heat certification such as gas, electric, or oil) before advancing to hydronic certification.

C. Competencies covered:

1. Hydronics I
 - a. hydronic heating systems;
 - b. gas fired boilers;
 - c. electric boilers;
 - d. oil fired boilers;
 - e. circulating pumps;
 - f. piping arrangements;
 - g. temperature control devices;
 - h. zone controls;
 - i. Operating sequence.
2. Hydronics II
 - a. steam heating systems;
 - b. gas fired boilers;
 - c. electric boilers;
 - d. oil fired boilers;
 - e. piping arrangements;
 - f. temperature control devices;
 - g. zone controls;
 - h. operating sequence.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10) and R.S. 17:10.

HISTORICAL NOTE: Promulgated by the Department of Education, Board of Elementary and Secondary Education, Trade and Industrial Education, LR 31:

Chapter 25. National Skills Standards

§2501. Safety and Environment

- A. Understand and apply safety regulations and procedures.
- B. Understand and apply federal, state, and local regulations for disposing of hazardous materials.
- C. Understand and apply United States Environmental Protection Agency (EPA) regulations on venting, recovery, reclaiming, and recycling refrigerants.
- D. Understand and apply the U. S. Department of Transportation (DOT) regulations in the transportation and handling of hazardous materials.
- E. Understand and apply U. S. Occupational Safety and Health Administration (OSHA) regulations.
- F. Understand and apply Environmental Protection Agency (EPA) regulations on indoor air quality and nitrous oxide.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10) and R.S. 17:10.

HISTORICAL NOTE: Promulgated by the Department of Education, Board of Elementary and Secondary Education, Trade and Industrial Education, LR 31:

§2503. Electrical Principles

- A. General
 - 1. Understand and apply the principles of alternating and direct current.
 - 2. Understand and recognize the common single-and three-phase voltage system including 231v, 60hz, single phase; 208v, 60hz, three-phase; and 460v, 60hz, three-phase systems.
 - 3. Understand and apply the principles of series-parallel and compound circuits.
 - 4. Understand and apply the principles and relationships of Ohm's, Kirchhoff's, and Watt's Laws as they apply to series-parallel and compound circuits.
 - 5. Read and interpret voltage, ampere, ohm, megohm, and wattmeters.
 - 6. Read and interpret schematic drawings.
 - 7. Develop schematics from electrical label/line diagrams.
 - 8. Read and interpret electrical codes.
 - 9. Understand and apply the properties and behaviors of electrical conductors and insulators.
 - 10. Understand and apply the principles of electrical circuit protection including fuses, circuit breakers, and disconnect switches.
 - 11. Understand and apply the principles of single-and three-phase transformers.
 - 12. Understand and apply electrical grounding principles.
 - 13. Understand and apply the principles of electrical measurement.
 - 14. Troubleshoot electrical circuits.
 - 15. Install electrical power and control circuits.
 - 16. Install and connect the components of electrical circuits.
- B. Electric Motors
 - 1. Understand and apply the operating principles of electric motors.
 - 2. Understand and recognize the application of various types of electric motors.

3. Understand and recognize the application of various types of capacitors.
4. Understand the principles and operation of electric motor protection devices.

5. Understand and interpret electric motor specifications.
6. Install and connect electric motors.
7. Perform electrical motor maintenance.
8. Troubleshoot electric motors.

C. Controls

1. Understand and apply the principles of safety and operating control devices (e.g., pressure switches, thermostats).
2. Understand and apply the principles of electromechanical control devices (e.g., relays, contactors, magnetic starters, timers, sequences).
3. Understand and apply the principles of electronic control devices (e.g., ignition modules, electronic timers).
4. Understand and apply the principles of safety and control circuits.
5. Install/service mechanical control devices.
6. Install/service electromechanical control devices.
7. Troubleshoot mechanical control devices.
8. Troubleshoot electromechanical control devices.
9. Troubleshoot electronic control devices.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10) and R.S. 17:10.

HISTORICAL NOTE: Promulgated by the Department of Education, Board of Elementary and Secondary Education, Trade and Industrial Education, LR 31:

§2505. Refrigeration Principles and Practices

A. General

1. Understand and apply the theory of heat.
2. Understand and apply the properties of refrigerants.
3. Understand and apply the mechanical refrigeration cycle.
4. Understand and apply pressure/temperature curves and charts.
5. Understand and apply the principles and the operation of compressors.
6. Understand and apply the principles and operation of condensers.
7. Understand and apply the principles and operation of metering devices.
8. Understand and apply the principles and operation of evaporators.
9. Understand the operation of refrigeration system accessories (e.g., receivers, accumulators, filter/dryers, sight glasses, valves).
10. Perform leak tests.
11. Evacuate and measure the vacuum level of refrigeration systems.
12. Recover refrigerants.
13. Charge refrigeration systems.
14. Recycle refrigerants.
15. Troubleshoot mechanical refrigeration systems.

B. Piping

1. Understand and apply the principles of piping systems, including the factors that affect pipe selection, pipe size, and system design.

e.g.:

2. Understand and select the proper fitting or valve for specific applications
 - a. globe valves;
 - b. gate valves;
 - c. angle valves;
 - d. check valves;
 - e. elbows, tees;
 - f. unions;
 - g. couplings;
 - h. half unions.
3. Understand and apply the principles of pipe accessories e.g.:
 - a. flanges;
 - b. isolators;
 - c. hangers;
 - d. expansion joints;
 - e. expansion loops;
 - f. supports;
 - g. insulation.
4. Perform copper tubing operations, including:
 - a. cutting;
 - b. flaring;
 - c. soldering;
 - d. brazing;
 - e. bending;
 - f. swaging; and
 - g. etc.
5. Perform steel pipe operations, to include:
 - a. cutting;
 - b. reaming;
 - c. threading;
 - d. connecting; and
 - e. etc.
6. Perform PVC pipe operations, including:
 - a. cutting;
 - b. connecting; and
 - c. etc.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10) and R.S. 17:10.

HISTORICAL NOTE: Promulgated by the Department of Education, Board of Elementary and Secondary Education, Trade and Industrial Education, LR 31:

§2507. Air Conditioning Principles

- A. Understand and apply the principles of air-conditioning, including temperature, humidity, and air movements, etc.
- B. Understand and apply the principles of air distribution and delivery systems.
- C. Understand and apply the principles of condensate drain systems.
- D. Understand and apply the principles of air filtration systems.

- E. Design air distribution systems.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10) and R.S. 17:10.

HISTORICAL NOTE: Promulgated by the Department of Education, Board of Elementary and Secondary Education, Trade and Industrial Education, LR 31:

§2509. Heating Principles

- A. Understand and apply the principles of fuel system design.
- B. Understand and apply the principles of air and hydronic distribution and delivery system design.
- C. Understand and apply the principles and operation of electric resistance heat systems.
- D. Understand and apply the principles and operation of gas-fired, forced-air heating systems.
- E. Understand and apply the principles and operation of oil-fired, forced-air heat systems.
- F. Understand and apply the principles of electric heat pump systems.
- G. Understand and apply the principles and operation of gas-fired hydronic heat systems.
- H. Understand and apply the principles and operation of oil-fired hydronic heat systems.
- I. Understand and apply the principles of venting and drain systems.
- J. Understand and apply the principles of pipe sizing and layout for both fuel and heat distribution.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10) and R.S. 17:10.

HISTORICAL NOTE: Promulgated by the Department of Education, Board of Elementary and Secondary Education, Trade and Industrial Education, LR 31:

§2511. Residential and Light Commercial Heating

- A. Understand and apply the principles of fuel system design.
- B. Understand and apply the principles of air distribution system design.
- C. Understand and apply the principles and operation of electrical resistance heat systems.
- D. Understand and apply the principles and operation of gas-fired, forced-air heating systems.
- E. Understand and apply the principles and operation of oil-fired, forced-air heating systems.
- F. Understand and apply the principles and operation of gas-fired hydronic heat systems.
- G. Understand and apply the principles and operation of oil-fired hydronic heat systems.
- H. Understand and apply the principles of venting and drain systems.
- I. Understand and apply the principles of pipe sizing and layout, including liquid propane and natural gas and oil.
- J. Understand and apply the principles of humidification.
- K. Install/service gas-fired forced-air heating systems.
- L. Install/service oil-fired forced-air heating systems.

- M. Install/service hydronic heat systems.
- N. Fabricate/install/service venting and drain systems.
- O. Install/service humidifiers.
- P. Troubleshoot gas-fired forced-air heating systems.
- Q. Troubleshoot oil-fired forced-air heating systems.
- R. Troubleshoot hydronic heat systems.
- S. Troubleshoot venting and drain systems.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10) and R.S.

17:10.

HISTORICAL NOTE: Promulgated by the Department of Education, Board of Elementary and Secondary Education, Trade and Industrial Education, LR 31:

§2513. Heat Pump

- A. Understand and apply the principles of vapor compression heat pump cycles.
- B. Understand and apply the principles of supplementary heat.
- C. Understand and apply the relationship of outdoor ambient temperature to heating capacity.
- D. Understand and apply the electrical circuitry of air-to-air, and group-to-air heat pumps.
- E. Understand and apply the principles and operation of defrost controls in heat pump systems; e.g:
 - 1. electronic demand defrost;
 - 2. pressure;
 - 3. time/temperature;
 - 4. time; and
 - 5. etc.
- F. Understand and apply the principles of the balance point of heat pumps.
- G. Interpret the balance chart and plot the balance point of a heat pump.
- H. Design air distribution and delivery systems.
- I. Fabricate and insulate air distribution systems.
- J. Install/service vapor compression heat pump systems.
- K. Troubleshoot vapor compression heat pump systems.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10) and R.S.

17:10.

HISTORICAL NOTE: Promulgated by the Department of Education, Board of Elementary and Secondary Education, Trade and Industrial Education, LR 31:

§2515. Residential and Light Commercial Air Conditioning

- A. Understand and apply the principles of air-conditioning including:
 - 1. temperature;
 - 2. humidity;
 - 3. air-movement; and
 - 4. etc.
- B. Understand and apply the principles of air distribution systems.
- C. Understand and apply the principles of condensate drain systems.
- D. Understand and apply the principles of air filtration systems.
- E. Design air distribution and delivery systems.
- F. Fabricate and insulate air distribution systems.

- G. Install air distribution systems.
- H. Install/service condensate drain systems.
- I. Install/service air filtration systems.
- J. Install/service split air-conditioning systems.
- K. Install/service packaged air-conditioning systems.
- L. Install/service evaporative coolers.
- M. Troubleshoot air-conditioning systems.
- N. Troubleshoot evaporative coolers.
- O. Troubleshoot condensate drain systems.
- P. Troubleshoot air filtration systems.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10) and R.S.

17:10.

HISTORICAL NOTE: Promulgated by the Department of Education, Board of Elementary and Secondary Education, Trade and Industrial Education, LR 31:

§2517. Commercial Air Conditioning Systems

- A. Understand and apply the principles of cooling towers.
- B. Understand and apply the principles of pneumatic control devices, e.g.:
 - 1. thermostats;
 - 2. pneumatic actuators;
 - 3. pneumatic switches; and
 - 4. pneumatic relays.
- C. Understand and apply the principles of pumps and circulators.
- D. Understand and apply the principles of low and high-pressure gas-fired boilers.
- E. Understand and apply the principles of low and high-pressure oil-fired boilers.
- F. Understand and apply the principles of steam condensers and traps.
- G. Understand and apply the principles of water-cooled condensers and accessories.
- H. Understand and apply the principles of desiccant cooling and dehumidification systems.
- I. Understand and apply the principles of liquid chillers and accessories.
- J. Understand and apply the principles of air distribution and delivery systems.
- K. Understand and apply the principles of water distribution systems.
- L. Understand and apply the principles of commercial conditioned-air control systems.
- M. Install/maintain/service pneumatic control devices.
- N. Install/service pumps and circulators.
- O. Install/align shafts in fans, pumps, and open-type compressors.
- P. Install/service cooling towers and accessories.
- Q. Install/service water-cooled condensers and accessories.
- R. Install/service liquid chillers and accessories.
- S. Install/service air distribution systems and accessories.
- T. Install/service water distribution systems and accessories.
- U. Install/service commercial conditioned-air control systems.
- V. Perform scheduled monitoring/testing procedures of commercial conditioned-air systems.
- W. Perform preventive inspection and maintenance procedures of commercial conditioned-air systems.

- X. Perform commercial conditioned-air system start-up procedures.
- Y. Perform commercial conditioned-air system shut-down procedures
- Z. Troubleshoot pneumatic control devices.
- AA. Troubleshoot pumps and circulators.
- AB. Troubleshoot cooling towers and accessories.
- AC. Troubleshoot water-cooled condensers and accessories.
- AD. Troubleshoot liquid chillers and accessories.
- AE. Troubleshoot air distribution systems and accessories.
- AF. Troubleshoot water distribution systems and accessories.
- AG. Troubleshoot commercial conditioned-air control systems
- AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10) and R.S.

17:10.

HISTORICAL NOTE: Promulgated by the Department of Education, Board of Elementary and Secondary Education, Trade and Industrial Education, LR 31:

§2519. Commercial Refrigeration

- A. Understand and apply the principles of high, medium, low, and ultra-low temperature control refrigeration and their applications.
- B. Understand and apply the principles of mechanical refrigeration systems in commercial refrigeration, e.g:
 - 1. walk-in coolers;
 - 2. walk-in freezers;
 - 3. reach-in cases;
 - 4. multiple evaporator systems;
 - 5. packaged refrigeration systems.
- C. Understand and apply the principles of electric and hot gas defrost systems in commercial refrigeration systems.
- D. Understand and apply the principles of flake and cube icemakers.
- E. Understand and apply the principles of water coolers.
- F. Understand and apply the principles of specific refrigeration system components used in commercial refrigeration, e.g:
 - 1. low ambient controls;
 - 2. evaporator pressure regulators;
 - 3. crankcase pressure regulators.
- G. Understand and apply the principles of load calculation and piping designs in commercial refrigeration systems.
- H. Calculate the load, design the piping system, and design the control system of a commercial refrigeration system.
- I. Install/service commercial refrigeration systems.
- J. Install/service ice makers.
- K. Install/service water coolers.
- L. Troubleshoot high temperature commercial refrigeration systems.
- M. Troubleshoot medium temperature commercial refrigeration systems.
- N. Troubleshoot low temperature commercial refrigeration systems.
- O. Troubleshoot ultra-low temperature commercial refrigeration systems.
- P. Troubleshoot icemakers.
- Q. Troubleshoot coolers.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10) and R.S. 17:10.

HISTORICAL NOTE: Promulgated by the Department of Education, Board of Elementary and Secondary Education, Trade and Industrial Education, LR 31:

Chapter 27. Program Standards

§2701. HVACR Excellence Program Standards

- A. Standard 1. Mission of Program
 - 1. Mission for Program Students
 - 2. Program Mission and Description
- B. Standard 2. Administration Responsibilities
 - 1. Competency of Student upon Completion
 - 2. Backing of the Institution's administration
 - 3. The Institution's Requirements
 - 4. Lab/Work Projects
 - 5. HVACR Program Advisory Committee
- C. Standard 3. Finances and Funds
 - 1. Student's Fees
 - 2. Annual Budget for HVACR Program
 - 3. Formulation of Budget
- D. Standard 4. Teaching/Learning Materials
 - 1. Maintenance and Repair Reference Materials
 - 2. References and Periodicals
 - 3. Multimedia Materials and Equipment
- E. Standard 5. Student Services
 - 1. Pre-admission Procedures
 - 2. Counseling
 - 3. Student Transcripts
 - 4. The School-to-Work Transition
 - 5. Student Follow-up Information
- F. Standard 6. Plan of Instruction
 - 1. Over-all Program Design
 - 2. Students per Instructor Ratio
 - 3. Specialized Training Plan
 - 4. Safety
 - 5. Work Habits
 - 6. Basic Skills
 - 7. Worker Characteristics
 - 8. Performance Standards
 - 9. Student Progress
 - 10. Evaluations
 - 11. Articulation Agreements
- G. Standard 7. Physical Facilities
 - 1. Safety
 - 2. Classroom and Office
 - 3. Maintenance and Housekeeping
 - 4. Shop/Lab Area
 - 5. Tool Room and Storage Area
 - 6. Restrooms
- H. Standard 8. Equipment and Tools
 - 1. Shop/Lab Equipment

2. Hand Tools for Students
3. Supplies
4. Parts Replacement/Repairs
- I. Standard 9. Cooperative Training
 1. Performance Standards
- J. Standard 10. Instructor Qualifications
 1. Qualifications

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10) and R.S. 17:10.

HISTORICAL NOTE: Promulgated by the Department of Education, Board of Elementary and Secondary Education, Trade and Industrial Education, LR 31:

§2703. Competencies, Foundation Skills, Academic Cross References

A. Standard: Heating, Ventilating, Air Conditioning, and Refrigeration Competencies (National Skills Standards: Air Conditioning, Heating and Refrigeration Technician. Consortium of States, 1996.)

Benchmarks	Louisiana Foundation Skills	Academic Cross-Reference (Standard-Benchmark)
A. SAFETY		English Language Arts (ELA)
(1) Identify types, purposes, and operation of fire extinguishers.	1, 3, 5	ELA 1 – H1, H3, H4, H5
(2) Inspect shop for hazards.	1, 2, 3	ELA 2 – H1, H2, H3, H4, H5, H6
(3) Work cautiously and safely, using appropriate tools.	1, 3, 5	ELA 3 – H1, H2, H3
(4) Demonstrate victim removal procedures from an electrical conductor.	1, 2	ELA 4 – H1, H2, H3, H4, H5, H6
(5) Demonstrate safe handling of refrigerants.	1, 2	ELA 5 – H1, H2, H3, H4, H5, H6
(6) Demonstrate safe handling of pressurized gases.	1, 2	ELA 7 – H1, H2
(7) Demonstrate safe handling of combustibles.	1, 2	
(8) Apply MSDS (Material Safety Data Sheet) information to material use.		Mathematics
(9) Adhere to applicable local, state and federal regulations (EPA [environmental], DOT [moving vehicle] and OSHA [worker safety]).		N – 1H, 2H, 3H, 4H, 5H, 6H, 7H D – 7H, 9H
(10) Demonstrate first aid for occupational hazards.		A – 1H, 2H, 3H, 4H
B. BASIC ELECTRICITY (General)		M – 1H, 2H, 3H, 4H
(1) Apply the principles of alternating and direct current.	1, 2, 3	G – 1H, 2H, 3H, 4H, 5H, 6H
(2) Differentiate between common single- and three-phase voltage systems, including 240V, 60Hz, three-phase; and 480V, 0 Hz, three-phase systems.	1, 2, 3	Social Studies
(3) Read and interpret voltage, ampere, ohm and wattmeters.	1, 2	G – 1A-H1, 1A-H2, 1D-H1, 1D-H2, 1D-H4, 1D-H5
(4) Read and interpret electrical schematic and wiring diagrams.	1, 2	E – 1A-H1, 1A-H2, 1A-H3, 1A-H5, 1B-H1, 1B-H2, 1B-H4, 1B-H5, 1B-H6
(5) Install electrical power and control circuits.		

Benchmarks	Louisiana Foundation Skills	Academic Cross-Reference (Standard-Benchmark)
(6) Apply the principles and relationship of Ohm's Law as it applies to series, parallel, and series-parallel circuits.	1, 2	H – 1A-H1, 1A-H2, 1A-H5, 1A-H6
(7) Apply the principles of electrical circuit protection, including fuses, circuit breakers, disconnect switches and grounds.	1, 2	Science SI-H – A1, A2, A3, A4, A5, A6, A7, B3, B4, B5
		PS-H – C1, C2, D1, D6, D7, E1, E2, E3, E4, F1, F2, G1, G2, G3, G4
		ESS-H – A1, A2, A3, A5, A6, A7, B1, D7
		SE-H – A1, A2, A11, B1, B2, B3, B4, B5, B6, C1, C2, C3, C4, C5, D1, D2, D3, D4, D5, D6
BASIC ELECTRICITY (Electric Motors)		
(1) Apply the operating principles of electric motors.	1, 3, 5	
(2) Recognize the application of various types of electric motors.	2, 3	
(3) Recognize the application of various types of capacitors.	3, 4	
(4) Test capacitors.		
(5) Explain the principles and operation of electric motor protection devices.		
(6) Interpret electric motor specifications (e.g., horsepower, voltage).		
(7) Install and connect electric motors.		
BASIC ELECTRICITY (Controls)		
(1) Apply the principles of safety and operating control devices (e.g., pressure switches, thermostats).	3, 4	
(2) Apply the principles of electromechanical control devices (e.g., relays, contactors, magnetic starters, timers, sequencers).	2, 3, 4	
(3) Apply the principles of electronic control devices (e.g., ignition modules, electronic timers).	2, 3, 4	
(4) Apply the principles of safety and control circuits.	1, 3, 5	
(5) Install/service mechanical control devices (e.g., pneumatic and water controls).	2, 3	
(6) Install/service electromechanical control devices.	3, 4	
(7) Install/replace transformers.	2, 3, 4	
C. REFRIGERATION PRINCIPLES AND PRACTICES		
(1) Explain principles of refrigeration.	2, 3, 4	
(2) Explain heat transfer theory.		
(3) Identify refrigerant and oil types, characteristics and uses.	2, 3, 4	
(4) Use gauge manifold set.	2, 3, 4	
(5) Leak-test system.		

Benchmarks	Louisiana Foundation Skills	Academic Cross-Reference (Standard-Benchmark)
(6) Evacuate and measure vacuum level to 500 microns.		
(7) Recover refrigerants.		
(8) Charge system to manufacturer's specifications.		
(9) Describe the operation of refrigeration system accessories (e.g., receivers, accumulators, filter/dryers, sight glasses, valves).		
REFRIGERATION PRINCIPLES AND PRACTICES (Piping)		
(1) Identify different types of tubing and fittings.	1, 3, 5	
(2) Perform copper tubing operations, including cutting, flaring, soldering, brazing, bending, swaging, etc.	2, 3	
(3) Install, repair and replace aluminum tubing.	3, 4	
(4) Install and replace PVC tubing and pipe.		
(5) Perform gas pipe operations (e.g., cutting, reaming, threading and connecting).		
D. AIR CONDITIONING		
(1) Understand and apply the principles of air-conditioning, including temperature, humidity, and air movement, etc.	2, 3, 4	
(2) Understand and apply the principles of air distribution and delivery systems.	2, 3, 4	
(3) Understand and apply the principles of condensate drain systems.	2, 3, 4	
(4) Understand and apply the principles of air filtration systems.		
(5) Design air distribution systems.		
E. HEATING		
(1) Understand and apply the principles of fuel systems design.	1, 3, 5	
(2) Understand and apply the principles of air and hydronic distribution and delivery system design.	2, 3	
(3) Understand and apply the principles and operation of electric resistance heat systems.		
(4) Understand and apply the principles and operation of gas-fired forced-air heat systems.		
(5) Understand and apply the principles and operation of oil-fired forced-air heat systems.		
(6) Understand and apply the principles of electric heat pump systems.		
F. RESIDENTIAL/LIGHT COMMERCIAL COOLING/HEATING		
(1) Install or replace compressor.	1, 3, 5	
(2) Install or replace condensing unit.	2, 3	
(3) Install or replace condenser.	3, 4	
(4) Repair or replace evaporator.		
(5) Replace, repair and adjust metering devices.		

Benchmarks	Louisiana Foundation Skills	Academic Cross-Reference (Standard-Benchmark)
(6) Perform cleanup of a contaminated system.		
(7) Describe operation of a heat pump.	2, 3, 4	
(8) Start and check residential heating and cooling systems.	2, 3, 4	
(9) Measure and adjust conditioned airflow.	2, 3, 4	
(10) Repair, replace and service electronic air cleaner.		
(11) Pump down unit.		
G. HEAT PUMPS		
(1) Understand and apply the principles of vapor compression heat pump cycles.	1, 3, 5	
(2) Understand and apply the principles of supplementary heat.	2, 3	
(3) Understand and apply the relationship of outdoor ambient temperature to heating capacity.		
(4) Understand and apply the electrical circuitry of air-to-air, and ground-to-air heat pumps.		
(5) Understand and apply the principles and operation of defrost controls in heat pump systems (e.g., electronic demand defrost, pressure, time/temperature, time).		
H. RESIDENTIAL/LIGHT COMMERCIAL AIR CONDITIONING		
(1) Understand and apply the principles of air-conditioning, including temperature, humidity, and air movement, etc.	3, 4	
(2) Understand and apply the principles of air distribution systems.	2, 3, 5	
(3) Understand and apply the principles of condensate drain systems.		
(4) Understand and apply the principles of air filtration systems.		
(5) Design air distribution and delivery systems.		
(6) Fabricate and insulate air distribution systems.		
I. COMMERCIAL AIR CONDITIONING SYSTEMS		
(1) Understand and apply the principles of cooling towers.	1, 3, 5	
(2) Understand and apply the principles of pneumatic control devices (e.g., thermostats, pneumatic actuators, pneumatic switches, pneumatic relays).	2, 3	
(3) Understand and apply the principles of pumps and circulators.	3, 4	
(4) Understand and apply the principles of low and high pressure gas-fired boilers.	2, 3, 4	
(5) Understand and apply the principles of low and high-pressure oil-boilers.		

Benchmarks	Louisiana Foundation Skills	Academic Cross-Reference (Standard-Benchmark)
(6) Understand and apply the principles of steam condensers and traps.		
(7) Understand and apply the principles of water-cooled condensers and accessories.	2, 3, 4	
(8) Understand and apply the principles of desiccant cooling and dehumidification systems.	2, 3	
(9) Understand and apply the principles of liquid chillers and accessories.	2, 3, 4	
(10) Understand and apply the principles of air distribution and delivery systems.	2, 3, 4	
(11) Understand and apply the principles of water distribution systems.	1, 3, 5	
(12) Understand and apply the principles of commercial conditioned-air control systems.	2, 3	
J. COMMERCIAL REFRIGERATION		
(1) Understand and apply the principles of high, medium, low, and ultra-low temperature control refrigeration and their applications.	2, 3, 4	
(2) Understand and apply the principles of mechanical refrigeration systems in commercial refrigeration (e.g., walk-in coolers, walk-in freezers, reach-in cases, multiple evaporator systems, packaged refrigeration systems).	2, 3, 4	
(3) Understand and apply the principles of electric and hot gas defrost systems in commercial refrigeration systems.	2, 3, 4	
(4) Understand and apply the principles of flake and cube icemakers.	2, 3, 4	
(5) Understand and apply the principles of water coolers.	2, 3, 4	
(6) Understand and apply the principles of specific refrigeration system components used in commercial refrigeration (e.g., low ambient controls, evaporator pressure regulators, crankcase pressure regulators).	2, 3, 4	
(7) Understand and apply the principles of load calculation and piping designs in commercial refrigeration systems.	2, 3, 4	
(8) Calculate the load, design the piping system, and design the control system of a commercial refrigeration system.	2, 2, 4	

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